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ERRATA

Page 7, line 8, read Georgia for "Goergia."

Page 177, line 2 from bottom, period after Medicago sativa should be a comma.

Cover of September number, page numbers should be changed as follows: 406 to 408, 409 to 411, 422 to 424, 425 to 427, 428 to 430, 431 to 433.

Page 460, line 14 from bottom, read Bacillus instead of "Baccillus."

Page 516, reference 1, "malaides" should be maladies.

Page 516, reference 6, second line should be "Biol. Centralbl. 37: 373. 1917."

Page 527, line 21, change "inoculation" to inoculum.

Page 530, line 4 from bottom, change "play a role" to, play no role.

Page 532, reference 2, n should be omitted from "Mended."

Page 555, second paragraph, line 1, change "serniere" to derniere.

Gen (Sci lib)
Wahr

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PHYTOPATHOLOGY

VOLUME XIV NUMBER 1

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VARIETAL SUSCEPTIBILITY AMONG BEANS TO THE BACTERIAL BLIGHT

WALTER H. BURKHOLDER

Considerable progress has been made in New York State during the last few years, in the discovery of varieties and strains of beans (*Phaseolus vulgaris* L.) resistant to the various diseases to which this crop is subject, and in the developing of new strains of commercial varieties from such stock. Barrus (1) led the way by showing that the Wells' Red Kidney and the White Imperial were resistant to both the alpha and the beta strains of *Colletotrichum lindemuthianum* (Sacc. et Magn.) B. et C. From these two varieties, the writer (2), McRostie (8) and Reddick (9) have developed several other strains of commercial varieties of beans resistant to the anthracnose. A bush marrow introduced from Nova Scotia and reported upon recently by the writer (5) is being grown to a small extent in New York State and has proved more or less resistant to the anthracnose under field conditions. The appearance of a third strain of *C. lindemuthianum* designated as gamma (4) has seemingly complicated the breeding problem in respect to this disease. Varieties resistant to both alpha and beta strains are susceptible to the gamma strain. This third strain of the fungus, however, is of limited occurrence, and it is hoped at present that it will be of no economic importance.

Varieties of beans resistant to two other important diseases have been published upon in various articles. The Flat Marrow, a strain of beans resistant to *Fusarium martii phaseoli* Burkholder, the cause of a root-rot, was reported by the writer (3) and breeding experiments with this strain of beans were undertaken by McRostie (8). The most practical work, however, was the discovery at the Perry bean laboratory and the subsequent proving by Reddick and Stewart (10) that the Robust pea bean is immune to the mosaic disease. The growing of pea beans in New York had practically been discontinued due to this disease, but with the introduction of this bean, the acreage of the pea bean is now as large as formerly. From the Robust other varieties have been bred which are also mosaic resistant (8 and 9).

With the ever increasing prevalence of the bacterial blight caused by *Phytomonas phaseoli* (E. F. Smith) Committee S.A.B.,[1] strains of commercial varieties of beans resistant to this disease are greatly needed. Very few investigators have dealt with blight resistance among beans. Fulton (6) has reported some experiments and observations on varietal susceptibility, and recently Gloyer (7) has noted two distinct susceptible periods in the life of the bean plant; the seedling stage and that period from the formation of pods to maturity. With the beginning of the work reported in this article, it was noted from observations in the bean fields that none of the common varieties possess immunity. Single plant selection among these varieties likewise has shown no permanent resistance. Any variety of beans, then, having the character of blight resistance was desired for use as breeding stock. If this character behaved in a Mendelian fashion, as anthracnose resistance does, crosses with commercial varieties would no doubt yield a valuable type. Search for the character of blight resistance was begun in a systematic manner in 1919 and has been continued to the present time. No immune or highly resistant variety has been discovered, but certain degrees of susceptibility among the varieties have been noted which appear worthy of reporting. In this article an account is given of those experiments conducted in the field during the seasons of 1919, 1920, and 1921. The summers of 1922 and 1923 were not such to induce the rapid spread and development of the disease. This was also true of the summer of 1920, but the plots that year were inoculated a great many times so that infection was secured. Since infection was very light in all the fields that year, all varieties in the experimental plots showing a medium or light infection were considered to be rather susceptible, and were discarded from further tests. It was thought that they would approach a severe infection under favorable conditions.

In 1919 and 1920 the experimental tests were conducted at Perry, New York, and those in 1921 were at Ithaca, New York. The varieties of beans were planted in ten-foot rows which were about 28–30 inches

[1] Recently Miss Hedges (Science n.s. **55:** 433–434. 1922) reported on a disease of beans similar to the bacterial blight, the causal organism of which differed in her description but slightly from *Phytomonas phaseoli*. Many anomalies are to be met with in the bacterial blight which have formerly been considered due to ecological factors. It is probable that some of these are due to physiological differences in the pathogenes, and that the species *P. phaseoli* constitutes a group just as certain species pathogenic to animals are known to do. Bacterial blight in this article refers to the bacterial disease of beans as it occurs in New York State and described elsewhere by the writer (Phytopath. **11:** 61–69. 1921).

apart. After the plants were a little past the seedling stage, they were sprayed with a water suspension of the bacteria. The bacteria in some cases were obtained from pure cultures, and in other cases by chopping up blight-infected plants and soaking them in water. Three and four such inoculations were made until it was certain that sufficient inoculum for general infection was provided.

In table 1 are set forth the results obtained in 1919. Here three degrees of infection are recorded and are designated as *light*, *medium* and *severe*. The disease destroyed practically all the leaves of those varieties of beans placed in the group marked *infection severe*. Severe injury, too, was sustained by the pods. Those varieties in the group marked *infection light* showed considerably less injury although they did not possess sufficient resistance to make them valuable for breeding stock. The Robust pea bean is a good example of this group. Here the incubation period was approximately a week longer than in the former group. The spots on the leaves spread much more slowly and little injury was found on the stem and pods. Consequently unless infection was very early, serious damage did not occur to the plant. An intermediate group was formed for those varieties which were difficult to place in either of the above two groups. In table 2 are placed those varieties tested in 1920. During that season the disease was not severe on any of the varieties, as explained above, but it was considered that those showing the bacterial blight to any extent would be very susceptible in a blight-favorable year. In table 3 a similar grouping is made of those beans tested in 1921. Conditions were very favorable that year for the development and spread of the disease.

In looking over tables 1 and 3, one may observe that practically all those varieties showing a light infection in 1919 also remained in that class in 1921. This evidently demonstrates that those varieties do possess a certain amount of resistance. This resistance, too, is sufficiently great to recommend the use of these varieties in preference to similar ones in either of the other two groups. In general, however, the more resistant varieties are later in maturing, while those exhibiting severe infection are early. The correlation of the two characters, however, is not perfect.

A number of hybrids have been produced between the most resistant of the varieties in hope of increasing resistance. Very little progress has been made so far. The work is being continued, nevertheless, and further crosses are being made and tested.

TABLE 1—*Varieties of beans showing relative susceptibility to the bacterial blight during the season of 1919.*

INFECTION LIGHT

Baldwin Wonder Wax
California Pink
California Wonder Pea Bean
Early Golden Cluster Wax
Giant Stringless Valentine
Keeney's Stringless Green Pod
Kenney's Rustless Golden Wax
London Horticultural
Manchurian Pea
Pearce's Improved Tree Bean
Refugee 1000–1
Robust
Scotia
Scotia

INFECTION MEDIUM

Black Turtle Soup
Bountiful
Burlingame Medium
China Eye
Chutenashi
Detroit Wax
Dutch Case Knife
Diafuki
Early Mohawk
Extra Early Refugee Dwarf
Extra Early Red Valentine
Farquhar's Rustless Golden Wax
Full Measure
Giant Stringless Valentine
Gray Marrow (South America)
Harlequin
Hodson Wax
Japanese White Marrow
Kentucky Wonder
Longfellow (Bush)
Mammoth Stringless Bush Bean
Manchurian Cranberry
Marvel of Paris
Maules Profusion Wax
Michigan White Wax
Michigan Wonder Pea Bean
Nova Scotia Marrow
Perfection St. Louis White
Pencil Pod Black Wax
Pinto
Prolific German Black Wax
Prolific Tree Bean
Red Marrow
Refugee Wax
Rust Proof Golden Wax Bush
Triumph of the Frames
Vineless Marrow
Wells' Red Kidney
White Creaseback
White Wonderfield
White Imperial
Yellow Six Weeks

INFECTION SEVERE

Admiral Togo
Black Valentine
Boston Favorite
Brown Swedish
Challenge Dwarf Black Wax
Colossal Stringless Green Pod
Currie's Rust Proof
Davis Wax
Flat Marrow
Golden Wax
Improved Golden Wax
Isbell's Wonder Wax
Lazy Wife
Manchurian Kintoki
Masterpiece Dwarf Bean
Mexican Red
Michigan White Wax
Muroingen
Nagauzura
Plentiful
Old Mahogany
Ruby Horticultural
Tennessee Green Pod
Scarlet Flageolet Wax
Wardwell's Kidney Wax

TABLE 2—*Varieties of beans showing relative susceptibility to the bacterial blight during the season of 1920.*

INFECTION NONE

Admiral Togo
Burpee's Fordhook Favorite Bush
Crackerjack Wax
Crackerjack Wax
Crystal White Wax
Flageolet Violet Wax
German Black Wax
Giant Stringless Green Pod
Golden Eye Wax
Improved Yellow Eye
Isbell's Early Wonder Wax
Isbell's Favorite
Low's Champion
New Bountiful
New Dwarf Round Pod Intermediate Horticultural
Refugee 1000–1
Refugee Wax
Round Yellow Six Weeks
Round Yellow Six Weeks
Snowflake Field
Webber Wax
Worcester Mammoth

INFECTION LIGHT

Arlington Red Cranberry
Baldwin Wonder Wax
Black Wax
Bountiful
Brown Swedish
Burpee's Stringless Green Pod
Brittle Dwarf Wax
Brittle Wax
California Rust Proof Wax
California Wonder Field Bean
Chinese Sword Bean
Cornfield Pole
Crystal Wax
Cutshort
Dwarf Hardy Wax
Early Six Weeks
Early Yellow Six Weeks
Extra Early Refugees
Extra Early Red Valentine
Fairfield Wonder Wax
Giant Stringless Green Pod
Giant Stringless Green Pod
Golden Wax
Improved Prolific Tree
Isbell's Golden Butter Wax
Jordan's Stringless Self Drier
Keeney's Rustless Golden Wax
Kentucky Wonder Wax
Leonard's Webber Wax
London Horticultural
Longfellow
Low's Early Champion
Masterpiece
Missouri Wonder
Nancy Davis
New Yellow Pod Bountiful
Old-Fashioned Striped Sickle
Pheasant's Eye
Prolific Black Wax
Refugee 1000–1
Refugee Wax
Scotia
Snow Flake
Stringless Green Pod
Stringless Kidney Wax
Sure Crop
Superior
Tennessee Green Pod
Texas Pole
Unrivaled Dwarf Wax
Vineless Marrow
Warren
Wells' Red Kidney
White Kidney
White Kidney
White Seeded Kentucky Wonder
White Sickle
White Wonder
Wonder of France
Yard Long

INFECTION MEDIUM

Flat Marrow
French Asparagus
Perfection Pole Bean
White Kidney

TABLE 3—*Varieties of beans showing relative susceptibility to the bacterial blight during the season of 1921.*

INFECTION LIGHT

Baldwin Wonder Wax
California Pink
Carter's Climbing French Bean
French Mohawk
Harlequin
Italy's Favorite
Kenney's Rustless Golden Wax
London Horticultural
Mont d'Or
New Stringless Green Refugee
Robust
Scotia
Snowflake Field
Worcester
Yard Long

INFECTION MEDIUM

Arlington Red Cranberry
Atwater White Kidney
Burpees' Fordhook Favorite Bush
California Rust Proof Wax
Carter's July Climbing
Carter's Stringless Holborn Wonder
Carter's Sunrise
Carter's White Model Dwarf French Bean
Condon's Earliest Market
Condon's "Sure Crop" Stringless
Crystal White Wax
Early Golden Cluster Wax
French Asparagus
Giant Stringless Green Pod
Golden-Eye Wax
Kenney's Stringless Green Pod
Lightning Early Valentine
New Bountiful
New Dwarf Intermediate Horticultural
New Kidney Wax
Old-Fashioned Sickle
Osborn's Early Forcing
Refugee 1000-1
Refugee Wax
Royal Dwarf White Kidney
Rustless Golden Wax
Southern Cornfield Bean
Unrivaled Dwarf Wax
Ventura Wonder
White Mexican Tree
Yosemite Mammoth Wax

INFECTION SEVERE

Admiral Togo
Best of All
Blue Pod Medium
Brittle Wax
Burpee's Saddleback Wax
Canadian Glory
Carter's Longsward
Carter's Magpie
Carter's Perpetual
Crackerjack Wax
Currie's Rust Proof Wax
Eureka
Flageolet Violet Wax
Golden Eye Wax
Green Seeded Flageolet
Isbell's Favorite
Isbell's Early Wonder Wax
McCaslon Pole
New Yellow Pod Bountiful
Round Yellow Six Weeks
Southern Prolific Pole
Sure Crop Wax
Webber Wax
White Sickle
Yard Long Pole
Yellow Eye

In 1919 some inoculation experiments were conducted on some species closely related to *P. vulgaris* which should be reported here. These

were carried along with the variety tests and in the same manner. All species tested during that season proved more or less susceptible. They are as follows: Henderson's Bush Lima [*Phaseolus lunatus* L.], the white Tepary [*P. acutifolius* Gray var. *latifolius* Freeman], the moth bean, [*P. aconitifolius* Jacq.], the Adzuki bean [*P. angularis* (Willd.) W. F. Wright], the Mung bean [*P. aureus* Roxb.], the California Black-eye cowpea [*Vigna sinensis* (L.) Endl.], the Ito San variety of the soy bean [*Soya max* Piper], and the Goergia Velvet bean [*Stizolobium deeringeanum* Bert.].

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PLANT PATHOLOGY IN THE DUTCH EAST INDIES

CARL HARTLEY AND R. D. RANDS

The Dutch East Indies have been the scene of pioneer studies in tropical plant pathology.[1] These studies in most cases were initiated in response to some disease problem or crisis connected with the plantation industry in which many millions of European capital was early invested. Under the stimulus of acute losses from disease the managers of these great European estates in Java and Sumatra were not slow to want aid in preventing possible disaster. Most of them were growing exotic species, in vast pure stands which occupied the same soil year after year. The Government botanical institution at Buitenzorg, Java, a rendezvous of botanists from all countries of the world attracted by its famous gardens, was naturally called upon not only for direct help but also for guidance in the establishment of planters' experiment stations to study the various problems of the industry. As a result there now exists a large amount of published matter. With the exception of Japan, this probably exceeds in volume the literature from all other parts of Asia and the Pacific islands, though it is less familiar to American botanists than that from certain other parts of the Orient. The following account is based on three years' experience in plant pathological investigation in the islands of Java and Sumatra.

A short general statement about the Dutch East Indies may be helpful for the orientation of American readers. The Archipelago stretches out along the equator for a distance of about 3000 miles from Asia to Australia. It has about eight times the land area of our Philippines, with a population four times as great (47 million) and of much the same ethnic composition, though mainly Mohammedan. The distribution of this population is peculiar, in that three-fourths of it is crowded together on the island of Java, which is recently volcanic and very fertile but smaller than the state of New York. In contrast to the highly developed condition of Java, Borneo and New Guinea, each approximately the size of France, are not even completely explored. A great variety of agricultural conditions is met with, ranging from hot coastal plains with strictly tropical crops, to high, cool slopes and plateaux where northern plants are grown. Climate is in general very moist, but with

[1] The terms "plant pathology" and "plant disease" are used in this paper with the meanings which they commonly carry in the United States and therefore do not include abnormalities caused by insects and higher animals.

actually arid conditions in some parts during the dry season. In the regions with developed agriculture rice is the great native food crop, with maize, cassava (tapioca), sweet potatoes, peanuts, and a number of others less important. For export, sugar is the great crop, with rubber, tea, coffee, coconut products, tobacco, spices, and quinine, all grown on a considerable scale as plantation crops under European management. Despite the great importance of the primarily plantation crops in Java, their total area is not more than one tenth of that occupied by the native food crops.

Aside from some valuable mineral resources, plants and their products are the prime interest of both whites and natives in the islands, and the Europeans recognize well their need of help from the plant scientist. The excellent steamers connecting Java with Singapore are named in honor of the biologists Rumphius and Treub, and the latter boat is decorated with bronze tablets bearing lists of Treub's publications. Semi-technical abstracts of agricultural contributions appear prominently in the daily papers. A list of twenty-four series of technical publications containing botanical literature appearing in the Dutch East Indies is appended to this paper. The large number is due to the maintenance of separate series of *mededeelingen* (contributions) for each government laboratory and each of the planter's experiment stations.

DISEASES WHICH HAVE RECEIVED SPECIAL ATTENTION

Plant pathology has received its chief stimuli from diseases of four important plantation crops: the Hemileia leaf-rust of coffee, which became epidemic between 1880 and 1890; the *sereh* and associated diseases of sugar cane, which also began to receive attention in the eighties; the *Bacterium solanacearum* wilt of tobacco which became prominent with the extension of this industry in north Sumatra; and the brown-bast of Hevea rubber, recognized as an independent disease only in the last decade. The early coffee epidemic resulted in disaster in Java, as elsewhere. Little investigative work of the modern type has been done on the disease itself in Java, the situation being met by the substitution of other crops or of inferior but more resistant coffee varieties. The resulting changes, however, were undoubtedly influential in bringing about the establishment of experiment stations, supported chiefly by the planters themselves, for the perennial plantation crops.

The sugar cane diseases stimulated more direct investigative attack, and were influential in causing the founding of the sugar experiment station, which became and has remained through a long period of years

the most important private agricultural investigative enterprise in the world. The book of Wakker and Went[1] on sugar cane diseases, abundantly illustrated in color, published in 1898, is an evidence of the early activity in sugar cane disease investigation. Intensive pathological investigations were not continued to the point of thoroughly distinguishing, and determining the causes of, several of the important cane diseases, but some further work is now being done. In the meantime, development of resistant varieties and such indirect methods as the growing of clean propagating stock in localities which remain free from disease have resulted in fairly satisfactory economic control of the recognized troubles.

In 1893, tobacco became the subject of intensive investigations, first in the form of planter-supported research administrated by the Buitenzorg Botanical Garden, and more recently in the privately established and controlled *Proefstations* at Medan in Sumatra, and Klaten and Djember in Java. This development was largely due to the losses suffered from *Phytophthora nicotianae* in the seed beds.[2] This disease still remains a principal subject of investigation at the station at Klaten, while the wilt due to *Bacterium solanacearum* has become the chief pathological problem in Sumatra. Extensive studies of the wilt organism have been published.[3] Sanitation measures have been developed against both diseases, which appear to have economic value, but in neither case is the control as yet on a satisfactory basis. The work at Klaten has served as the basis for the publication of a recent manual on diseases and pests of tobacco, well illustrated in color.[4]

Hevea or Pará rubber, arising as an intensively handled major crop almost over night, and after the idea of scientific work on plantation crops had become well established, received from the first of its short history, more or less attention from the disease standpoint. After a time it was realized that dry tapping cuts, brown inner bark, and troublesome "burr" growths were all common manifestations of the brown-bast disease, and were causing so much loss as to endanger the

[1] Wakker, J. H., and F. A. F. C. Went. De Ziekten van het suikerriet op Java' Deel I, Ziekten, die niet door dieren veroorzaakt worden. *217 p., 25 pl. (16 colored)*' Leiden, 1898

[2] Encyclopaedië van Nederlandsch Oost-Indië. **4:** 98–99. 1921.

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[4] Jensen, Hj. Ziekten van de Tabak in de Vorstenlanden. *171 p., 36 fig., 58 pl. (25 in color)*. Leiden, 1921. (Also issued as Meded. **40,** Proefsta. voor Voorstenlandsche Tabak.)

future of the industry. A definite investigative drive was at length made against the disease, the Dutch authorities cooperating with the planters' organizations, and the technical workers representing the interested parties throughout Malaysia keeping in communication with one another. Results were prompt and quite satisfactory. A complete change in tapping methods and surgical treatment of trees already give promise of reducing the loss from this trouble to a negligible minimum. The disease is believed to be non-parasitic, a direct result of too frequent tapping, and excessive latex removal.[1]

In addition there may be noted a number of problems which have aroused less interest. Cacao canker and pod rot (*Phytophthora faberi* Maub.) have received intermittent attention for 20 years; both crop and disease have now so dwindled in importance that further study in Java seems unwarranted. Pepper, a native crop of rather large export value, has disappeared from certain sections where it was formerly important, largely as the result of a trouble which despite some investigative effort[2] still remains obscure. The peculiar "blood disease" of bananas in Celebes, a vascular bacterial trouble, has proved very serious.[3] In the course of its investigation a general search for vascular banana diseases has been made, and an entirely different bacterial wilt,[4] usually chronic instead of acute, has been found nearly universal both in Celebes and Java. In this chronic disease there is an interesting secondary flora, consisting largely of Fusaria and other bacteria, some components of which may aid in producing the diseased condition. This disease seems to offer an exceptional opportunity for investigating the relative importance of primary and secondary organisms. Only etiological work has been done on these banana diseases, and unfortunately nothing more is now in prospect.

[1] Rands, R. D. Brown bast disease of plantation rubber, its cause and prevention. Dept. Landb., Nijv , en Handel (Dutch East Indies). Inst. Plantenziek. Meded. **47.** *57 p. 5 pl.* 1921.

[2] For a summary of the literature on the subject see, Gäumann, E. A. Enkele opmerkingen omtrent de Lampongsche peperziekte. Teysmannia **33:** 289–293. *2 text figs.* 1922.

[3] Gäumann, E. Onderzoekingen over de bloed ziekte der bananen op Celebes. I. Dept. Landb., Nijv., en Handel (Dutch East Indies), Inst. Plantenziek. Meded. **50.** *49 p., 6 pl.* 1921.

[4] Gäumann, E. Over een bacterieele vaatbundelziekte der bananen in Nederlandsch-Indië. Dept. Landb. Nijv. en Handel (Dutch East Indies), Inst. Plantenziek. Meded. **48.** *135 p., 18 fig., 8 pl. (1 in color).* 1921. Comparisons of this trouble with the "Panama disease" of the West Indies are discussed by *Brandes, E. W.* Onderzoek op grooten afstand betreffende de verwelkings-ziekte der bananen. Teysmannia **33:** 294–297. 1922. (See also postscript by E. A. Gäumann in reply to this, pp. 297–300).

Individual pieces of work, mostly recent, have been done on the Sclerospora mildew of corn,[1] and on diseases of quinine,[2] of peanut,[3] and of potato.[4] A curious Phytophthora stripe canker of cinnamon, sometimes several meters in length, but never more than a few centimeters in width, with a definitely daily-zonate length extension of almost invariably 1 cm. per day, which could not be correlated with physical factors, has been investigated in Sumatra.[5]

A disease conspicuous by its practical absence in the Malay Peninsula[6] as well as in the Dutch possessions is the epidemic bud rot of coconut, and the various other evidences of Phytophthora attack on coconut noted in British India. This is the more interesting, as bud rot has made serious trouble on both sides of the Dutch Indies, in the Philippines as well as in India. Another disease less serious than in the Philippines is the Sclerospora maize disease. Recent mycological work has indicated that the Sclerospora and the common Phytophthoras of the palmivora-faberi type of the Philippines are quite different from those of Java.[7] The Phytophthoras at least differ in parasitic ability as well as in morphological characters, and a difference in parasites may therefore explain the differences in disease prevalence in both these cases.

Forest pathology has been chiefly limited to some recent publications of the forestry experiment station at Buitenzorg on non-parasitic troubles in the intensively handled teak forests. Of the pathology of the tre-

[1] Palm, Bj. Onderzoekingen over de omo lyer van de mais. Dept. Landb., Nijv., en Handel (Dutch East Indies). Lab. Plantenziekt, Meded. **32:** *77 p., 7 pl.* 1918. (With English summary.)

[2] Rant, A. Five recent papers (see bibliography by Van Overeem—de Haas, Lc.).

[3] (a) Palm, B. T Aanteekening over slijmziekte in Arachis hypogaea (Katjang tanah). Dept. van Landb., Nijv., en Handel (Dutch East Indies), Inst. Plantenziek. Meded. **5.** *41 p., 2 fig.* 1922. (W.th English summary.)

(b) Groenewege, J. Landbouwkundige onderzoekingen over de slijmziekte. Dept. Landb., Nijv., en Handel (Dutch East Indies), Meded. **12.** *79 p., 16 pl.* 1922.

(c) Hartley, Carl and Schwarz, M. B. Papers soon to be published.

[4] Paravcini, E. Die Kartoffel krankheiten in Niederländisch—Ost Indien. Centralbl. Bakt. Abt. 2, **58:** 212–220 Mr. 1923.

[5] Rands, R. D. Streepkanker van kaneel, veroorzaakt door Phytophthora cinnamomi n. sp. Dept Landb., Nijv., en Handel (Dutch East Indies), Inst. Plantenziek. Meded. **54:** *54 p., 6 pl. (1 in color).* 1922. (With English summary.)

[6] Sharples, A. and J. Lambourne. Observations in Malaya on bud-rot in coconuts. Ann. Bot. **36:** 55–70. *Pl. I–VII.* 1922.

[7] Weston, W. H. Philippine downy mildew of maize. Jour. Agr. Research **19:** 97–122. 1920.

Recent unpublished work by the senior writer on the variability in Phytophthora of the *P. faberi* type.

mendous variety of tree species in the higher altitude "wildhout" forests, practically nothing is known, beyond the enumeration of 40 mistletoe species[1] and the occurrence and mycological data given by Raciborski[2] and others on some of the parasitic fungi.

A large number of purely mycological papers scattered through European and East Indian periodicals have been published. Many of the descriptions in these, unfortunately, were based only on the study of dried specimens brought back to Europe by travellers some of whom were not even botanists, so that the status of a number of genera and species is uncertain. A valuable survey and compilation of the existing literature has been made by van Overeem,[3] recently appointed mycologist to the Buitenzorg Botanical Garden. In addition he gives a list of all the fungi he has been able to find reported to date for the Netherlands Indies. Of special interest to the pathologist are the papers on parasitic species in which notes on severity and distribution accompany the descriptions. The most important of these involving a series of three papers is by Raciborski, who describes a large number of interesting parasites on a variety of host plants. Despite the seemingly extensive mycological literature, comparatively little is known of the rich fungus flora of the islands. Intensive study along this line will be seriously handicapped by the local deficiency of comparative material, since most of the collections and exsiccati of new genera and species are in private herbaria scattered through Europe.

In general, plant diseases are abundant in Java, especially on recently introduced crops and in case of many vegetables where the seed is imported every year. Here one may observe not only the common diseases with which he is familiar in colder climes, but often new ones indigenous to the tropics which have spread over from native host plants. An instance of this is the glume spot of wheat caused by *Nigrospora javanica* Zimm.,[4] a parasite apparently reported only from Java, which prior to the introduction of wheat into the island had been found only on a species of Panicum, and on rice and maize. However, one coming from the

[1] Koorders, S. H. Exkursionsflora von Java **2:** 155–167. Jena, 1912.

[2] Raciborski, M. Sixteen papers on the fungi of Java, 1897–1909. For citations see p. 140–141, and especially citation No. 190 of van Overeem's bibliography, l. c.

[3] Overeem-de Haas, C. et D. van. Verzeichnis der in Niederländisch Ost-Indien bis dem Jahre 1920 gefundenen Myxomycetes, Fungi, und Lichenes. Bull. Jard. Bot. Buitenzorg Ser. III, **4:** 1–146. 1922.

[4] Palm, Bj. Eenige ziekten waargenomen aan de tarwe op Java. Dept. Landb., Nijv., en Handel (Dutch East Indies), Inst. Plantenziek. Meded. **34:** 17–18. *Fig. 11, 12.* 1918.

Temperate Zone is a little surprised at not finding still more numerous and conspicuous diseases in so warm and moist a country. Raciborski, perhaps the keenest observer who has looked for parasites in Java, remarks that at first he was unable to see them because the novelty of the vegetation in general distracted his attention. However, even after that wore off, he did not think that he found as many things (referring to parasites of the natural vegetation) as he would in an equal length of time in Europe. This indicates the difficulty of locating indigenous species rather than an actual paucity of number. For example, one of the writers searched nearly two years before finding Raciborski's *Phytophthora colocasiae*, whereas under the variable monsoon climate of semi-tropical Bengal, Butler and Kulkarni report it very common and destructive. So rare are many of the new genera and species described by Raciborski and others in Java that the occasional finding of them is nothing short of a rediscovery. In a country with such great uniformity of climate and multiplicity of host species, the proportion of "rare" fungi is probably greater than in temperate regions where there is constant interference in the natural adjustment and establishment of equilibrium between parasite and host. There are doubtless also contributing factors which aid the host in offsetting the apparent advantage to the fungus of tropical temperature and moisture. The temperature ($\pm$ 30° C.) of Java is almost constantly above the optimum for a number of parasites, and its equability probably also assists the host plant in maintaining its equilibrium and resistance toward some others. The Wisconsin tests have emphasized the dependence of certain diseases on the occurrence of temperatures considerably above or below the mean.

Rainfall in most of Java ranges from 80–160 inches per year, decidedly more than the 30 inches of our Missouri Valley, the 45 inches of the Atlantic seaboard, or the rainfall figures for Europe. In much of West Java, the total precipitation exceeds the total evaporation. However, fog is rare, and rain when it comes is commonly heavy,[1] perhaps washing spores off of surfaces that might otherwise become infected. At low and moderate elevations, at which most crops are grown, nearly every morning in the year is clear and drying, at least for a few hours, even in the wettest districts.

[1] Taking the year, the weather records of which happen to come first to hand (1918), it is found that at Buitenzorg, which is situated at an elevation of 900 ft., there were 73 days on which rain reached cloudburst intensity, i. e., a rate of 1 mm. per minute for at least a 5-minute period. In a number of these cases the rain exceeded 2 mm. per minute for a period of 5 or more minutes.

AGENCIES ENGAGED IN PATHOLOGICAL INVESTIGATIONS

Up to the last half dozen years most of the pathological investigation had been done by the planters' stations previously referred to. As a result its publication has been scattered through semi-technical periodicals and numerous independent series of reports and *mededeelingen* (contributions), mainly in the Dutch language and many of them little known outside of Java. This accounts in considerable part for the lack of acquaintance of outsiders with what has been done. These stations have constituted a unique feature in the agricultural organization of the

FIG. 1.—The Government's Institute for Plant Diseases, Buitenzorg, Java. Approximately half of the building is here shown.

islands. Their development is largely due to the commendable policy of the Government in confining its own activities largely to the improvement of native agriculture and at the same time encouraging the European agricultural interests to handle their own specialized problems. The planters have now learned by experience that it pays them to finance investigative work on their own crops. There are at present eight independent private or mainly private planters' stations in Java

and two in Sumatra. The names of these stations, the crops studied, and the territory represented, are as follows:

Algemeen Proefstation der A.V.R.O.S., Medan, Sumatra. Rubber, oil palm, coffee, and all other plantation crops except tobacco in northeast Sumatra. Tea problems are studied in cooperation with the station at Buitenzorg. The building belonging to this station is shown in fig. 3.

Algemeen Proefstation voor de Theecultuur, Buitenzorg, Java. Tea; territory covered—entire Dutch East Indies.

Eesoekisch Proefstation, Djember, Java. Tobacco, rubber, coffee, and other "hill cultures," in extreme eastern end of Java.

FIG. 2.—Present staff of the Institute for Plant Diseases, Buitenzorg, Java The Director, Dr. C. J. J. van Hall, is at the center, seated, and Dr. Marie B. Schwarz, the pathologist, next to him. The other investigators are entomologists.

Centraal Rubberstation, (*Vereeniging Centraal Rubberstation*). Buitenzorg, Java. Studies primarily the chemistry and physical properties of t he product in cooperation with local stations; scope—Dutch East Indies.

Deli Proefstation, Medan, Sumatra. Tobacco on east coast of Sumatra.

Proefstation v/d. Java Suikerindustrië, Pasoeroean, East Java, and branches at Semarang, and Cheribon, central Java. Sugar.

Proefstation Malang, Malang, Java. Rubber and coffee in East Java.

Proefstation Midden Java, Salatiga, Java. Rubber, coffee, cacao, nutmeg, and coca (cocaine plant), in central Java.

Proefstation voor Vorstenlandsche Tabak, Klaten, Java. Tobacco in central Java.

Proefstation West Java, Buitenzorg, Java. Rubber in western Java. Now directed by the head of the tea station, with which it is likely to be combined.

FIG. 3.—Experiment Station of the A.V.R.O.S. (*Algemeen Vereeniging Rubberplanters Oostkust van Sumatra*), Medan, Sumatra. This is one of ten investigative and extension centers supported by the different planters' associations in Java and Sumatra.

In addition to the above a number of the larger plantation companies maintain investigative departments of their own, in which one or more botanists are employed, as the U. S. Rubber Co., Kisaran, Asahan, Sumatra, and the *Rubbercultuur Maatschappij Amsterdam*, Galang, Sumatra. All of the above stations are supported by strongly organized planters' associations by an annual tax, based on production or area under cultivation by the subscribing members. In the case of sugar,

for example, this amounted in 1922 to more than $0.90 per acre, giving the station an income of nearly $500,000. The other stations have smaller incomes, totalling approximately $400,000. Some of the stations are still aided by very small annual subsidies by the government and also receive contributions from business firms and individuals. While considerable research work is done at these stations, it is frequently insufficient as a basis for the extension work demanded by the planters. The average planter enjoys the proprietary feeling it gives him to have a scientifically trained man at his beck and call and he is frequently unhappy unless a visit is made to his plantation every so often, even though he has no immediate problem to solve. This takes time and tends to replace basic research by a great deal of desultory local experimentation. This situation, however, is realized by the people concerned and steps are being taken to differentiate more clearly between research and extension activities. Despite these difficulties, a large part of the remarkable progress of the plantation industry and the consequent rapid development of the colony in other respects is to be credited to the planters' stations.

The tobacco and sugar stations are the only ones with resources enabling them to attempt continuous research in pathology except incidentally to their extension activities. On account of the financial depression following the war, serious investigation of pathological problems will probably in the future, at least for some time, depend mainly on the government.

Government pathological work, together with the other plant protection lines, agricultural entomology, and the control of field rodents, is now theoretically limited to the *Instituut voor Plantenziekten* (Institute for Plant Diseases), established at Buitenzorg, Java, the seat of most of the government's agricultural investigations. Other subdivisions of the Department of Agriculture, as the quinine station, the general experiment station, the forestry experiment station, and the government rubber plantations, also engage more or less in pathological work. The *Instituut* (formerly known as *Laboratorium* and *Afdeeling*) was established ten years ago, but until 1919 counted only one botanist on its staff. Its botanical complement was then raised to two permanent positions, and two additional botanists have been employed for temporary periods.

FACILITIES FOR INVESTIGATIVE WORK

At Buitenzorg facilities for pathological work are on the whole very good. The *Instituut voor Plantenziekten* is in most respects well

equipped technically, and is located in a commodious new building (Fig. 1) in the midst of the 60-acre *Cultuurtuin* (economic garden devoted to plantation crops) and the selection garden of about equal area, where the investigative work on native crops is centered. The well known taxonomic garden, the large herbarium, and the large library of the Department of Agriculture are useful adjuncts. The herbarium, however, has been sadly deficient in fungi and the library shows gaps in numerous important places, particularly serious for the pathologist being the lack of bulletins of our state experiment stations. This latter deficiency seems to have been in considerable part due to the failure of many of our stations to maintain proper foreign mailing lists.

Assistance of low grade is available in abundance in the form of native "boys" able to read and write Malay and handle very elementary arithmetic. Their pay ranges from $5 to $20 per month. They can be used to advantage for making culture media, transferring cultures, running a microtome, and in field experiments, though most of them require very careful control. The Institute has a native photographer, a technologist, and native artists remarkably good with either ink or water color.

The planters' experiment stations vary considerably in the matter of equipment. At least the sugar station in East Java and the "Avros" station in northeast Sumatra seem to be particularly well provided with library facilities. The library of the Department of Agriculture at Buitenzorg maintains loan service for the entire Archipelago.

Especially in Sumatra and West Java the difference between the wet and dry seasons is so slight that one has to the full the tropical advantage of being able to run field experiments at any time of year, making possible much more rapid progress in some types of work than can be had in the Temperate Zone.

NON-INVESTIGATIVE ACTIVITIES

The only educational work in plant pathology is that given as a part of a 2-year course in botany in the Intermediate Agricultural School at Buitenzorg, a training school primarily for the native agricultural extension service. There is nothing corresponding to the College of Agriculture in the Philippines or the special training given to the natives who are detailed to the research laboratories at Pusa. The consequent lack of trained research assistants in the Dutch Indies is handicapping pathological investigation.

Extension work on the diseases of plantation crops is done very ef-

fectively by the planters' stations and the semi-technical journals. The government's Agricultural Information Service furnishes an avenue for the extension of knowledge of the methods of combating diseases of native crops. The government has done a great deal in furthering native agriculture.

A rough plant disease survey has been maintained for a number of years by monthly reports from the agricultural extension officials in Java and certain other well settled parts of the Archipelago, and by the annual disease reports from the planter's stations. These come to the Director of the Institute for Plant Diseases, who combines them with his own notes and the data on insect pests in an annual publication in the *Mededeeling* series of the Institute.

There is no nursery business of importance, and regulatory activities are practically limited to guarding against the introduction of foreign pests. This is controlled by the Institute under a new law. Propagating stock must be certified as pest-free by inspectors in the country of origin, and is admitted only through the port of Batavia, where it is again inspected, and sometimes brought to Buitenzorg for fumigation. Seed of about 30 genera of European vegetables and annual ornamentals are excepted from the operation of the law, as are all seed intended for consumption. Fruits for consumption are admitted, subject to inspection, at a few principal seaports. Limitation of propagating stock to a single port of entry does not work serious hardship for the reason that there is no importing business of importance in this line.

A single domestic quarantine, prohibiting the movement of bananas (fruit as well as plants) from Celebes to other islands or to any other part of the world, has been recently put into operation. This is due to the presence there of the "blood disease."

STATUS OF PLANT PATHOLOGY

For the Archipelago as a whole, plant pathology is still in the reconnaissance stage. The more conspicuous diseases are of course known, but experience in both Europe and America has shown that these are not necessarily the most important. There has been an unfortunate lack of continuity in disease investigation, a characteristic of most tropical studies, so that results of economic value have not generally been obtained. One of the government agriculturists at Buitenzorg has recently published a rather sharp attack[1] on pathologists in general for going

[1] Groenewege, J. Landbouwkundige onderzoekingen over de slijmziekte. Dept. Landb., Nijv., en Handel (Dutch East Indies), Meded. **12**. *79 p. 16 pl.* 1922.

only into the etiological aspects and thereby missing the additional opportunities for economic results that might come through further study of the diseases. There is a general impression that investigation of insect troubles is much more important than work on all other types of trouble combined. The Institute for Plant Diseases is now spending four times as much money on entomological projects as on pathological ones. The relatively low present standing of plant pathology seems to be in part due to the lack of continuity above referred to, and in part to the fact that pathological investigations have too often in the past been made by general botanists rather than by trained pathologists. It is believed that careful persistent work on some of the numerous little investigated crop plants would result in better appreciation of the economic value of pathological research.

A number of important problems or groups of problems are awaiting investigation, especially in connection with "native agriculture." The existence of serious diseases of the banana and of the pepper plant has already been mentioned. No control measures for these are known, and in the case of the pepper die-back the cause or causes have not been determined. Not even a thorough survey has been made of the diseases of such important food crops as rice, maize, cassava, and sweet potatoes, each of which in Java (with the exception of sweet potato) occupies an area from one to six times that of all plantation crops put together.

Although Java alone produces about 200 million bushels of rice annually there must be purchased in uncertain foreign markets approximately 20 million bushels additional to feed the native population. The local production of more rice is therefore one of the great problems of the East Indian Government. It is a well known fact that in a number of important districts the average yield per acre has been falling off in recent years and that crop failures are frequent. Some of these failures are traceable to the stem borer, drought, floods, etc., but those not due to such obvious causes are attributed to such a variety of agencies as to show on the face of the reports that the etiology is uncertain. All sorts of contradictory popular explanations of the failures are encountered: soil barrenness, too early planting, too late planting, untimely rains, improper cultivation, use of unsuitable varieties of rice, etc. A sucking insect which attacks the grain in the milk stage, and at least in West Java and Sumatra one or more fungi attacking leaves and seed, do considerable damage, but are not believed to be responsible for the entire failures noted. The hypothesis that nematodes are important as causes of rice disease in Java is not now generally credited. The condition known as *omo mentek*, also commonly referred to as root rot

by agronomists familiar with it, has been under investigation for years from the soil standpoint. The data obtained on the relation between soil aeration, atmospheric moisture, and the development of disease symptoms in rice are interesting and important; but the general problem of the rice failures seems to be too complicated to be explained on any simple basis. The likelihood of the presence of fungus or bacterial parasites able to attack the roots or the stems of the rice under favorable environmental conditions has never been investigated in the East Indies by modern methods. A thorough study of rice diseases in general, continued through a period of years by experienced pathologists cooperating with soils or physiological investigators, should prove more economical than the present very costly subterfuge of attempting to meet the increasing shortage by extension of the area under cultivation.

There has been some tendency for investigators to select problems without reference to the economic importance of the crops involved. This tendency has been by no means confined to the tropics. In the early work in most countries the diseases for investigation have been chosen because they were conspicuous, or because people of standing complained about them. This was in large part logical. The conspicuous disease is relatively easy to get data on. The disease that is complained of in the tropics is usually a plantation problem; the planter will help to get appropriations for investigation, will cooperate in the investigative work, and will ordinarily utilize any economic results obtained, while the native cultivator cannot be counted on to help in the work or to change his time-worn methods and prejudices readily enough to profit by the findings. But some of the plantation crops are not important. Work of maximum economic importance cannot be done on the less important crops. It is true that an unimportant crop sometimes has a disease especially favorable for the investigation of fundamental pathological questions, but fundamental research can in nearly all cases be more efficiently carried on in the temperate than in the torrid zone.

SUMMARY

1. The Dutch East Indies have in the past taken a leading part in tropical plant disease investigation. The more important diseases so far studied are noted. The clear mornings, equable temperature and lack of fog are considered factors in keeping down the seriousness of certain types of diseases.

2. Plant pathology does not have the standing with agriculturists that it should have, owing mainly to a tendency on the part of investigators

to leave a problem before they have worked long enough on it to get reliable results on the control aspects.

3. Much of the past pathological work has been done by the botanists of the various privately supported planters' stations. The number of investigators working mainly or entirely on plant diseases is now smaller than formerly.

4. Plant quarantine regulations are briefly described.

SERIAL BOTANICAL PUBLICATIONS OF THE DUTCH EAST INDIES

A. *Journals.*

Arch. Suikerindustrië (contains all Meded. v/h. Proefsta. Suikerindus.—sugar).
Arch. Rubbercult. (Contains all research work from "Centraal Rubber-station," "Proefstation West Java," and "Rubber Serië" of the "Algemeen Proefsta. A.V.R.O.S.").
Ann. Jard. Bot. Buitenzorg (systematic botany).
Bull. Jard. Bot. Buitenzorg (mainly systematic).
De Tropische Natuur (organ of the Netherl.-Indies Natural History Soc.).
De Thee (contains semi-popular articles, and reviews of technical articles on tea which appear in Meded. Proefsta. Thee.).
Tectona (official organ of East Indian forestry association).
Treubia (general biological journal).
Icones Bogoriensis (systematic—mainly descriptions of new species and genera).

B. *Serial Mededeelingen (Contributions) from Dept. Landb., Nijv., en Handel.* (Dept. Agr., Industry, and Trade, Buitenzorg Java.)

Meded. Algemeen Proefsta. v/d. Landbouw (agronomy and soil science).
Meded. Afdeeling Zaadteelt (selection and improvement of native crops).
Kórte Berichten van het Selectie en Zaadtuin (brief reports on plant selection).
Meded. Instituut voor Plantenziekten (plant diseases and insect pests).
Meded. Landbouw voor lichtingsdienst (agricultural extension service).
Meded Kina Proefstation (studies on quinine industry).
Meded. Proefstation voor Boschwezen (technical forestry articles).

C *Serial "Contributions" from planters' experiment stations.*

Meded. Besoekisch Proefstation (tobacco, rubber, and coffee).
Bull. Deli Proefstation (tobacco).
Vlugschrift Deli Proefstation (tobacco circulars).
Meded. Proefstation van den A.V.R.O.S. (Algemeen Serie.) (oil palm, etc.).
Meded. Proefstation Malang (rubber and coffee).
Meded. Proefstation voor Vorstenlandsche Tabak (tobacco).
Meded. Proefstation Midden Java (rubber, coffee, cacao, nutmeg, coca, etc.).
Meded. Proefstation voor Thee (tea).
Publicaties v/h. Nederlandsch Indisch Landbouw Syndicaat (Netherlands Indies Agricultural Syndicate, a union of planters' associations, publishes official minutes of planters' meetings and papers read).

There have just been received two interesting pamphlets on botanical and (agricultural) chemical investigations, parts of "The History and Present State of Scientific Research in the Dutch East Indies", published by the Koninklijke Akademie van Wetenschappen, Amsterdam, 1923.

ABSTRACTS OF PAPERS PRESENTED AT THE FIFTEENTH ANNUAL MEETING OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY, CINCINNATI, OHIO, DECEMBER 27, 1923 TO JANUARY 1, 1924.

Progress report on cabbage yellows investigations in Kansas. E. A. STOKDYK.

Three seasons' experiments in the greenhouse and field show that Wisconsin" All Seasons" and Wisconsin "Brunswick" are resistant to yellows if the seed is sown in a hotbed and the plants transplanted to the field. These varieties are susceptible in some cases if the seed is sown directly in the field. A selection of Copenhagen obtained from Iowa is giving considerable promise for Kansas conditions. Three varieties imported from Scotland have desirable qualities and some resistance.

Studies conducted to determine whether or not the causal organism is ever carried in or on the seed, have shown no direct evidence that either was the case. Several Fusaria have been isolated but they failed to produce yellows in cabbage or give the characteristic reaction of *F. conglutinans* on cooked rice.

F. conglutinans callistephi Beach, which causes Aster Wilt, failed to cause yellows in cabbage.

A progress report on black-rot investigations, with special reference to cauliflower on Long Island. E. E. CLAYTON.

Bacterium campestre overwinters rather frequently in the stems of surviving plants of cabbage and brussels sprouts. No cauliflower plants live over winter. Repeated attempts to secure infection in the spring with soil and plant refuse from previously infested cauliflower fields have failed. Cauliflower plants grown to maturity in cheesecloth cages have remained free from disease, while others just outside were badly attacked. Plants in the cages made an extremely luxuriant growth and were proven by inoculation to be more susceptible to the disease than those outside. Protecting plants from contact with cultivation tools, horses and man, by fencing, and from rain by a glass roof reduced the amount of disease. Negative results from attempts to spread the disease with worms, but observations point to other insects as major disseminators.

Control measures tested: (1) Removal of affected leaves or portions of leaves—no control. (2) Thorough poisoning of chewing insects—no control. (3) Spraying with Bordeaux plus a spreader—no control. (4) Seed and seed bed treatments—good control in several experiments. (5) Applications of lime and fertilizer influenced the amount of disease.

Control of black-rot and black-leg of cruciferous crops by seed and seed bed treatments. E. E. CLAYTON.

Bacterium campestre infected brussels sprouts seed and *Phoma lingam* infected cabbage seed were subjected to the following treatments with disease control as noted:

	Primary Systemic Black Rot	Black Leg
(1) Check	37.8%	24.5%
(2) $HgCl_2$: 1 to 1000 seed soaked 30 min.	18.6	3.0
(3) & (4) Hot water 50 C. seed soaked 25 and 33 min.	0	0.3
(5) $HgCl_2$: 1 to 1000 applied 3 times to plants in bed as for maggot control	0	2.4
(6) Bordëaux 4–5–50 applied same as (5)	22.3	4.5

Lots (3) and (4) stood transplanting with the least loss and made the most uniformly vigorous growth in the field.

Relation of soil temperature and soil moisture to infection by Plasmodiophora brassicae. JOHN MONTEITH, JR.

The influence of soil temperature and soil moisture on the development of clubroot on cabbage seedlings has been studied in the greenhouse using naturally infested soil at constant temperatures and with constant soil moisture throughout the experiments. Soil temperature appeared to have little influence on the development of clubroot except as it influenced host development. Clubbing occurred at all temperatures favorable for cabbage growth with the same optimum temperature for the disease as for normal host growth. Soil moisture was found to be a more influential factor than temperature in clubroot infection. In soil kept at a moisture content below 50% of the water-holding capacity the disease did not develop even though there was sufficient moisture for cabbage growth. Infection occurs with moisture from about one-half the water-holding capacity upwards, and the severity of the disease increases with the higher moisture content up to saturation. The disease may develop on the roots without severely checking the growth of the plant when the soil moisture is limited, but when the soil moisture is excessive the diseased roots are soon destroyed by secondary decay organisms and the plant dies.

Effect of the mercuric chloride treatment for maggot on Rhizoctonia and club-root of cabbage. W. O. GLOYER AND H. GLASGOW.

During the past three years of work on maggot control, it has been observed that mercuric chloride (1–1280) applied to cabbage seedlings reduced Rhizoctonia as well as maggot. In 1923 various maggot treatments were applied to four plantings (one each on clay and sandy soil and two on loam). A typical example of mercuric chloride plat where 1, 2 and 3 applications were made showed respectively 18 per cent, 4 per cent, and 2 per cent Rhizoctonia, while the check showed 59 per cent infected. Where tobacco dust controlled the maggot 83 per cent showed Rhizoctonia.

A similar planting test of 30 plats was made on a seed bed thoroughly infested with *Plasmodiophora brassicae*. Solutions of calcium hydrate, copper sulfate, ammoniacal copper carbonate and copper lime dust (13–87) had no effect on club-root. With mercuric chloride no club-root was found when only one application was made to the seedlings. This method of treatment appears a promising one for general soil sterilization when a plant needs the temporary aid of a fungicide while passing through a critical period of susceptibility to infection.

Susceptibility of species of Allium to onion smut. P. J. ANDERSON.

The usual explanation of the origin of onion smut is that it existed on some wild species of Allium before it migrated to the cultivated form. This explanation presupposes that there are other species which are susceptible. In order to determine whether such is the case seed from as many species of Allium as could be secured were planted in soil heavily infested with *Urocystis cepulae*. When the seedlings came up they were examined for smut lesions and the percentage of infection recorded. Sixteen of the 18 species tried were found to be susceptible to smut. *A. Cepa, Porrum, fistulosum, nutans* and *libani* are very susceptible. *A. nigrum, obliquum, ampeloprasum* and *Hookeri* are fairly susceptible. *A. polyphyllum, Scoradoprasum, volhynicum, fallax, daravasicum, sibiricum* and the Winterbeck onion are resistant but not immune. No smut occurred on *A. Ordoprasum* and *A. moly*.

Temperature relations of Urocystis cepulae (Frost). J. C. WALKER AND F. L. WELLMAN.

The relation of temperature to germination and growth of the onion smut fungus has been studied. Chlamydospores and the "hyphal fragments," the latter assuming certain functions of sporidia, germinate best at about 15° C. The minimum temperature for both is slightly below 9° C. Above 27° germination is meager, an occasional chlamydospore germinating at 30° to 32°. Growth of mycelium on favorable medium, such as onion agar, is best at about 22° and almost as good at 25°. There is decided reduction of growth at 27° and it practically ceases at 30° C. It would appear, therefore, that the inhibition of infection previously noted (Jour. Agr. Research **22**: 235. 1921.) at a soil temperature of 29°, or above, is due largely to the direct inhibiting effects of higher temperatures upon the development of the parasite.

Occurrence of white rot of Allium (Sclerotium cepivorum Berk.) in Europe and America. J. C. WALKER.

This disease is commonly destructive to onion and leek in the British Isles, Holland and France, and to garlic in Spain and Italy. The causal fungus has undoubtedly been introduced to this continent repeatedly with bulbs of onion and garlic. However, only two authentic reports of its occurrence in America have been made, from Oregon in 1918 (identified by Prof. Whetzel) and from Norfolk, Virginia, in 1923. In southern and northern Europe the disease is most destructive during the cooler spring or autumn periods. The causal fungus attacks all subterranean parts of the plant, eventually destroying roots and bases of the scales. Characteristic minute black sclerotia are formed abundantly within or upon the decaying host tissue. Laboratory studies show the organism to be favored by comparatively low temperatures. On potato agar most rapid growth is at 20° to 23° C. with a maximum at about 28°. Most vigorous infection takes place, however, at soil temperatures at 12° to 18°; much less occurs at 22° and practically none at 26°. It is to be expected that the disease would develop most readily in our southern sections where onion, garlic, and shallot are grown as winter crops.

A Fusarium bulb rot of onion. E. C. TIMS AND J. C. WALKER.

A Fusarium bulb rot of onion is commonly destructive in the onion set growing section of Illinois. It appears a few weeks before harvest and continues through the storage period. Infection ordinarily takes place at the stem plate and causes a dry to semi-watery decay of the scales, with yellowing and premature dying of the tops. In

August, 1921, a species of Fusarium was isolated from typical specimens of the disease and its pathogenicity was proved by wound inoculation of mature bulbs and growing plants. The temperature range for the disease both in storage and in soil is from 14° C. to 32° C., or above, with optimum development at about 26° C. The optimum temperature for growth of the fungus on potato dextrose agar is also about 26° C. Soil moisture has no direct effect upon the development of the disease under greenhouse conditions. The causal organism belongs to the section Elegans of the genus Fusarium. It apparently agrees except for certain minor characters with the rather inadequate description given for *Fusarium cepae* Hanzawa (Myc. Cent. **5**: 4. 1914).

Bean wilt (Bacterium flaccumfaciens Hedges). Further studies. FLORENCE HEDGES.

A wilt of navy bean was briefly described in Science in April, 1922. Field and greenhouse experiments have proved that the disease is seed borne and that the causal organism may live inside and on the surface of the seed and retain its virulence for at least five years. The parasite has been isolated from seed from Michigan, South Dakota, Montana, Maryland, District of Columbia, France and Germany. (Seed from seedsmen except in first two.)

The disease is primarily a wilt but it is occasionally accompanied by yellowing. No stomatal infections have been obtained.

Pods containing infected seed may appear perfectly sound or the infection may be seen following the suture bearing the seeds, sometimes broadening out from it somewhat. In immature pods the diseased area may be yellowish green and somewhat withered. Sometimes it appears more or less water-soaked. It is more conspicuous on the mature pods, the diseased area being discolored (greenish brown) while the rest of the pod is yellow.

Diseased seed may have a thick, bright yellow, bacterial layer beneath and showing through the seed-coat, or may be covered with slime externally or have only a small amount at the hilum. They resemble seeds infected with *Bacterium phaseoli*.

The effect of late planting on the bacterial blight of beans. W. O. GLOYER.

Wells' red kidney beans have been planted in parallel rows at intervals of ten days from May 29 to July 1, since 1917. Late plantings showed less disease than early plantings. For Geneva, N. Y. plantings made June 15 or later were free from weevil insect punctures (dimples) and least subject to blight. Two periods of susceptibility to blight were observed. The first period begins with the germination of diseased seed and ceases with the formation of the third leaf. The second period begins at pod formation and continues until maturity. Some resistant varieties and crosses owe their resistance to the delay of pod formation until the cool days of September.

Flowers and pods were picked from a hundred foot test row of red kidney beans on July 23, 27, Aug. 10, 17 and 23, 1923. At the last picking, the plants of this row were free from blight while 95 per cent of those of the next row, the check, were diseased. After 25 days without picking the test row showed a condition noted Aug. 23 on the check. This indicates that susceptibility to bacterial blight occurs when there is maximum translocation of nutrients.

Soy bean pustule. Comparative studies with Bacterium phaseoli sojense Hedges and Bacterium phaseoli E. F. S. FLORENCE HEDGES.

This disease, briefly described in Science in July, 1922, has been found on a large num-

ber of varieties of soy bean and is known to occur in Texas, Virginia, Louisiana, South Carolina and Kansas. Cross inoculations with *Bacterium phaseoli sojense* and *Bacterium phaseoli* E. F. S. showed that the former will infect Phaseolus but is much more infectious to soy bean while the latter is only very weakly pathogenic to soy bean. Spray inoculations made with *Bacterium phaseoli* E. F. S. on soy bean seedlings or older plants in an inoculating cage produced little or no results but excellent infections were obtained on the cotyledons of seedlings grown in damp chamber and inoculated therein as soon as they had germinated. No pustules have ever been observed in inoculations with *Bacterium phaseoli* E. F. S.

There is some evidence that passage through Phaseolus increases the virulence of *Bacterium phaseoli sojense* for the same. It produces no pustules but an infection resembling that caused by *Bacterium phaseoli* E. F. S.

The colonies of *Bacterium phaseoli sojense* on beef agar plates are commonly characterized by striking internal convolutions sometimes visible to the naked eye. It is often impossible to obtain the organism from dried leaves although it has been obtained from herbarium material 8 months old.

A new downy mildew on soy beans. S. G. LEHMAN AND FREDERICK A. WOLF.

A leafspot disease of soy bean caused by one of the downy mildews has been observed in several localities within North Carolina. The disease may be recognized by the presence of indefinite chlorotic areas which change to grayish brown irregular lesions with well defined dark brown borders. A dense grayish coating of conidiophores may cover the lower surface of the lesions. The causal organism is a species of Peronospora, which when compared morphologically with previously described species on legumes is manifestly distinct. It is accordingly described herein as a new species and is given the name *Peronospora sojae*.

Tomato wilt. R. P. WHITE.

Resistant varieties of tomatoes developed by numerous institutions have met with varying degrees of success in Kansas. The Louisiana Red and Pink varieties have proven the most resistant. From a limited amount of data, there are indications that resistance is recessive. Selections made from resistant individuals of a cross between a resistant and a susceptible parent in the F_2 generation have proven resistant in both the F_3 and F_4 generations. High soil temperatures have been found to increase the severity of the disease. Using a soil composed of one quarter sand and three quarters garden loam, it was found that soil moistures below 17 per cent of the dry weight and above 27 per cent of the dry weight prevented infection. The optimum soil moistures for infection were found to be between 20 and 25 per cent of the dry weight.

Some new methods and results in the control of lettuce diseases with formaldehyde. W. S. BEACH.

During three years in the culture of lettuce under sash near Philadelphia, Pennsylvania, sterilization of seed beds with formaldehyde—1–100 dilution applied a gallon to the square foot—decreased "drop" to losses of 1 to 3 per cent as compared with 8 to 35 per cent on unsterilized soil.

Aiming to reduce the excessive labor of applying a 1–100 dilution with watering-pots, experiments in applying the same amount of formaldehyde to like areas in dilutions of 1–33, 1–25 and 1–16 were conducted, more water to drench the soil being added with a

hose or portable Skinner irrigation. The results were 3.5 to 12 per cent infection as compared with 20 to 60 per cent on check plots. A large factor in the lower degrees of control was *Botrytis sp.*, it being controlled to a less extent than *Sclerotinia libertiana*. While the efficiency of these treatments was not ideal, the results were remunerative and large-scale application was possible.

In transplanting lettuce to the field in early spring, increases in marketable product of 14 to 51 per cent were obtained by the use of seedlings from sterilized seed beds, although the seedlings were set in unsterilized soil. These increases arise from the seedlings escaping infection by *S. libertiana*, *Botrytis sp.*, Rhizoctonia and probably other fungi.

A Sclerotium disease of Yautia. MEL. T. COOK AND RAFAEL A. TORO.

The Yautia (*Xanthosoma sp.*) is grown extensively in Porto Rico. During the past few months numerous reports of disease have been reported to the writers. It was at first supposed that this disease was due to an organism found by our predecessor, Mr. J. Matz; but study showed that most of the trouble was due to a Sclerotium which is the same or very similar to *S. Rolfsii*. Experimental work has demonstrated that this organism will attack the growing plants and cause a very rapid decay, but we have not as yet determined whether a wound is necessary. Mr. Matz left preserved material showing a Monilia-like organism but we have not yet been able to locate this organism in growing plants. We have also found a few cases of a decay apparently due to a different fungus but have not as yet determined its character.

Studies on Fusarium wilt of spinach in Texas. J. J. TAUBENHAUS.

During the last three years, the writer has come across a wilt of spinach which he has studied and which he found to be caused by a species of Fusarium. Recently, Hungerford has described a Fusarium wilt in Idaho which he named *Fusarium spinaceae*. From our own work, it seems that the spinach Fusarium in Texas is different from that in Idaho.

In addition to studying the pathology, morphology, and physiology of the causal organism, several varieties of spinach have been planted on badly infected soil. Of the many varieties tested, the New Zealand spinach was found to be very resistant.

An apple stem tumor not crown gall. NELLIE A. BROWN.

Apple stem tumor has been considered a type of crown gall by pathologists, entomologists and orchardists for a good many years. The crown gall organism, *Bacterium tumefaciens*, was isolated from galls at the crown of apple trees and from the hairy roots of apple trees by the writer in her early work with crown gall diseases. (These were proved, by inoculations.) The stem tumors were worked over occasionally but *Bacterium tumefaciens* was not isolated. However, the writer considered the disease a form of crown gall. In 1923 an extensive study of the disease was undertaken. Abundant material was received from various parts of the United States from which several hundred plates were poured. Sometimes colonies resembling those of *Bacterium tumefaciens* appeared on the plates. These, however, did not prove to be the crown gall organism as shown by culture or inoculation tests.

The presence of woolly apple aphis on stem tumors and on the numerous small swellings in the axils of the leaves appeared suspicious. Orchards were examined where stem tumors were abundant and the woolly apple aphis was found on the trees and on

the tumors themselves. Root galls produced by the woolly aphis were on the majority of these trees. While the fact of their responsibility has not been proved, the evidence is strong.

Relations of temperature and moisture to the development of crown gall. A. J. RIKER.

Experiments with crown gall conducted on tomato indicated that the size of galls developed on stems under soil, which was kept at 14°, 18°, 22°, 26°, 30°, and 34° C., increased with the temperature up to about 22° and then decreased. Considerable inhibition appeared at 30° and above. On stems in the air no galls were secured at temperatures above 32°. Galls developed in soil in a series of containers, in which the moisture content was regulated at 20, 40, 60, and 80 per cent respectively of the water-holding capacity of the soil, showed larger size with increased moisture up to 60 per cent. Those developed in soil containing 80 per cent moisture developed about as those in 40 per cent. The increased size of galls with higher temperatures and larger amounts of moisture was partly correlated up to 22° with the greater size of the plant. The tallest plants were secured at 30° and 80 per cent moisture, while the largest galls were found at 22° and 60 per cent moisture.

Strawberry leaf-scorch. FREDERICK A. WOLF.

This disease was first collected in Europe nearly one hundred years ago and has been known in the United States for nearly forty years. Collections have been made in New York, Connecticut, New Jersey, Indiana, West Virginia, Wisconsin, Montana, Maryland, Louisiana, Tennessee, Florida, and North Carolina. It is regarded as the most destructive disease of this crop in North Carolina.

Purplish to reddish lesions which coalesce and involve the entire leaf surface give to the plant a burnt appearance, hence the common name. Affected plants may be weakened and succumb during summer. The disease appears also upon petioles, fruit pedicels and calyx lobes. The impairment of the fruit results largely from the infection of the calyx.

The organism has two stages, acervuli which are subcuticular of the Marsonia type and ascocarps. Connection between the stages has been demonstrated by the appearance of both on the same lesions, by growth in pure culture and by inoculation experiments. Species of Potentilla are not subject to infection by this organism. Study of the morphology and development of the ascocarp shows that it is one of the Phacidiales, not one of the Pezizales as has hitherto been believed.

The grey bulb-rot of tulips. H. H. WHETZEL AND JOHN M. ARTHUR.

This disease long known in Holland and Germany as the sclerotium disease of tulips is here reported apparently for the first time from America. The identity of the pathogene with the fungus described by Klebahn as *Sclerotium tuliparum* has been established. A critical study of the fungus indicates that it is a Rhizoctonia rather than a Sclerotinia as suggested by Klebahn. The organism is therefore transferred to the former genus under the name *Rhizoctonia tuliparum* (Klebahn) nov. comb. No perfect stage has been discovered.

Soil disinfection experiments made in October, 1923, indicate that the fungus may be effectively eradicated from infested soil by the application of formaldehyde solution at the rate of 1 lb. (40 per cent) formalin per 5 square feet of soil surface. The drench used was made up at the rate of one part formalin to fifty parts water and was applied 12

days before planting the bulbs. Control plots showed in April, 1923, but 6 to 8 per cent of a stand while the treated plot gave a stand of 96 per cent.

A sclerotial disease of cultivated Delphinium. D. S. WELCH.

Specimens of diseased Delphinium were sent to the Department of Plant Pathology at Cornell University from Long Island, N. Y., Pennsylvania, Indiana and New Jersey. The stalks and especially the crowns of these plants showed signs of the presence of some fungus. Sclerotia were found attached to the diseased portions and cultures from these as well as tissue plantings from the interior of the stalks yielded the same type of organism in every case. Growth on potato dextrose agar produced abundant white mycelium and a considerable number of sclerotia which were very irregular in shape and size, 0.1 to 1.5 cm. or larger and often coalescing in masses, white at first, changing through buff and tan to dark brown but never to black. Clamp connections were found in the mycelium. Inoculation experiments showed that the organism is readily pathogenic to both the annual and perennial varieties of cultivated Delphinium. The progress of the disease is very rapid, the lower leaves become slightly yellowed and the upper leaves may still be green and scarcely wilted when the plant falls over due to the death of the tissues at the crown. This fungus cannot be identified with any described species and the author proposes the name *Sclerotium Delphinii* to designate this pathogene.

Notes on the Nematospora disease of lima beans. H. W. ANDERSON.

A Nematospora closely resembling *Nematospora phaseoli* Winegard was found prevalent in a field in southern Illinois. The seeds were obtained about two years ago from California and the grower has used his own seed exclusively. No other beans have been grown in the neighborhood. Dried lima beans bought in a local (Champaign) grocery supposedly obtained from California in 1922 showed this disease. A survey of the large commercial lima bean sections should be made to determine the distribution of the disease and measures should be taken to prevent its introduction into new areas since infected fields are a total loss.

A cytological study of this Nematospora shows clearly its relationship to the true Ascomycetes but indicates some peculiar variations in the nuclear behavior.

Fusion of m nute active cells indicates a true sexual conjugation, but the cells are so small that it is impossible to determine the nuclear behavior after fusion.

The name of the American brown-rot Sclerotinia. J. B. S. NORTON AND WALTER N. EZEKIEL.

For years the taxonomy of the Sclerotinia causing brown-rot of stone and sometimes pome fruits in America has been in doubt. Extensive cultural and inoculation experiments have confirmed the results of H. Wormald, and shown that the American species is distinct from not only the European *S. fructigena* but also from *S. cinerea*. The writers propose the name *Sclerotinia americana* (Wormald) comb. nov. for the common American species. (*S. cinerea* (Bon.) Schroeter, forma *americana* Wormald; Ann. Bot. **33:** 361–404. 1919, and **34:** 143–171. 1920.) This is the fungus, widely destructive in this country, whose apothecial stage was described by Norton, and which was studied and described by Reade, Matheny, etc.

The species mentioned can be differentiated macroscopically on potato-glucose agar

plates by variations in the rate of growth, production of conidia and aerial hyphae, and shape and elevation of the colony.

Strains of the brown-rot fungus, Sclerotinia americana WALTER N. EZEKIEL.

Variation within the species of Sclerotinia causing brown-rot of stone and pome fruits in this country has been previously noted. In studies with single-spore strains extending over a period of more than three years, the writer has been able to prove by repeated series of cultures, inoculations, reisolation and reinoculation, that these variations are genetic characteristics of the respective strains and not responses to environmental influences. The cultural characteristics of *Sclerotinia americana* strains are, under given conditions, invariant for each strain. Continued cultivation under similar conditions does not remove distinctions between strains; nor has cultivation under different conditions induced variations within a single strain when it is again grown under uniform conditions.

Hyphal anastomosis may take place in agar plates at the junction of colonies of dissimilar as well as similar strains and species. It is suggested that strains may arise from such fusions within rotting fruits.

On the physiology of the genus Phytophthora. LEON H. LEONIAN.

Sixteen species of Phytophthora were grown in a nutrient solution of known composition; the vigorously growing mycelium was then washed in terile distilled water and transferred to various solutions of one hundredth molar concentration. Nine sugars, six amino-acids, four organic acids, and two basic salts have been tried thus far. All of the organic acids and some of the amino-acids inhibited, more or less generally, the zoosporangia formation. The remaining amino-acids, the sugars, and the basic salts induced an abundant asexual reproduction. Single food constituents suppressed oogonia and stimulated zoosporangia, while a proper combination of these gave rise to oogonia as well.

Air supply constitutes the chief factor in reproduction. A lack of food was not found to be a controlling factor, since large quantities of zoosporangia formed even when the cultures were transferred to a fresh supply of nutrient solution every day.

Ten new synthetic and semi-synthetic solid media were developed and the organisms were studied in these. Not only the rate and the nature of growth, zoosporangia and oogonia production showed sharp specific characteristics, but the shape and size of the mycelium exhibited very profound and typical changes.

Spore germination of Phytophthora infestans. B. N. UPPAL.

Very little is understood regarding the effect of various substances on spore germination. Spores of *Phytophthora infestans* were placed under favorable conditions for germination, except that oxygen around the cultures was eliminated by an air pump, by the potash-pyrogallol method, and by its replacement with a nitrogen atmosphere. Germination occurred when air pump and nitrogen atmosphere were used. In the potash-pyrogallol method, when the desiccator was placed in the refrigerator immediately, there was some germination; but if the desiccator was held at 20° to 22° C. for a while before removing it to 10° C., germination became very doubtful. The absorption of oxygen is very slow in cool air, and it is also believed that by slow absorption of oxygen there is abundant production of CO.

High boiling products of crude petroleum—vaseline, paraffin-wax, and paraffin oil—stimulated germination, vaseline affording a remarkable stimulus. On the other hand, low boiling products—petroleum ether and gasoline—at the bottom of the moist chamber, inhibited germination; methyl alcohol and formaldehyde, under similar conditions, also inhibited germination. Vaseline more than offsets the inhibitory effect of gasoline, but in other cases the inhibition was complete.

The best germination occurred in 1 per cent of sugars. In 16 per cent, inhibition of germination is associated with high osmotic pressure, which brings about plasmolysis. Cellulose and sugars appear to act differently at about 2 per cent and lower concentrations.

Summary of investigations on clover rusts. W. H. DAVIS.

Results of observations, inoculations within the species and reciprocal inoculations with rust spores of Uromyces sp. removed from our common clovers, white, *Trifolium repens* L.; red, *Trifolium pratense* L.; alsike, *Trifolium hybridum* L. and mammoth, *Trifolium medium* L. are as follows:

1. The rust on white clover is autoecious, an eu form and a separate species, *Uromyces trifolii-repentis* (Cast.) Liro.

2. The rust on red clover is autoecious, an eu form and a separate species, *Uromyces trifolii* (Hedw. f.) Lév.

3. Mammoth clover is parasitized by *Uromyces trifolii* (Hedw. f.) Liro.

4. The rust on alsike clover is autoecious, an eu type and a separate species, *Uromyces hybridi* Davis.

5. Sowings of aeciospores, urediniospores and teliospores from alsike clover failed to infect white, red, medium and crimson clover (*Trifolium incarnatum* L.) but infected alsike clover producing the characteristic spore forms.

6 The principal morphological difference noted is that the inner and the outer walls of the peridial cells in the aecium from *T. hybridum* are thinner than those of the aecia in *T. repens* and *T. pratense*. The morphological difference between the rust on *T. hybridum* and that on *T. repens* is more striking than between the rusts on *T. repens* and *T. pratense* which are classified as two different species.

Conjugation in the aecium of Dicaeoma distichlidis E. J. PETRY AND LYNN D. HUTTON.*

From field observations of the senior writer, made in 1921, it was suspected that aecia found on leaves of *Steironema ciliatum* (L.) Raf. were caused by telia on *Spartina cynosuroides* (L.) Roth. The latter were intimately mingled with young Steironema shoots whose lower leaves were affected. New infections on young leaves, after rains, explained this location of the first aecia found.

The rust, after further study, was referred to *Dicaeoma distichlidis* (Ellis and Ev.) Kuntze, whose aecial stage on Steironema had already been connected with the telial stage on Spartina.

Since the aecial material would lend itself to ordinary histological methods the writer decided to see if conjugation stages similar to those found in several rusts by other investigators exist here. Briefly stated, some of the results are as follows:

1. Pycnia and aecia arise from uninucleate mycelium and are functionally unrelated in aeciospore formation.

* Junior Author.

2. The aecial hymenium consists of the conjugated ultimate or penultimate cells of the subhymenium.

3. The size of the conjugation aperture through which one of the conjugating nuclei passes, varies in different cases.

4. "Trichogynal" and "buffer" cells of several authors were found. These disappear before maturity of the aeciospores.

An undescribed imperfect fungus associated with wheat foot-rot in Oklahoma. H. H. MCKINNEY.

The writer found this fungus and also *Helminthosporium sativum* associated with a foot-rot of wheat grown near Woodward, Okla., in 1923. Young cultures of this fungus can not be distinguished macroscopically with certainty, from cultures of *H. sativum*. Older cultures of the undescribed fungus differ from the latter, however, in that they develop numerous sclerotial structures and a sclerotial crust on the surface of potato-glucose agar. The conidia are light to dark brown in color, elliptical in form, tri-septate, and are borne in clusters containing from two or three to fifty or more, on simple or branched conidiophores. Conidia produced on host tissue have been found to average $12 \times 30\mu$ in size. From the standpoint of conidia this fungus might be classified as a Helminthosporium or a Brachysporium, depending on the point of view accepted.

Inoculation studies show that the fungus is parasitic on the underground parts of wheat seedlings. The type of injury resembles closely that produced by *Helminthosporium sativum*. The parasite is of unknown economic importance.

(Cooperative investigations by the Wisconsin Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Studies on predisposition of wheat and corn to seedling blight caused by Gibberella saubinetii. JAMES G. DICKSON, SOPHIA H. ECKERSON, AND KARL P. LINK.

Wheat seedlings blight when grown in a warm soil, above 12°; corn seedlings blight when grown in a cool soil, below 20° C. Wheat, therefore, is predisposed to blighting at the higher and corn at the lower soil temperatures. Limiting soil moisture or light intensity likewise predisposes the seedlings to blighting and limits their response to temperature.

Mycelial penetration, where no blighting occurs, is limited to a slow digestion of the middle lamellae, whereas, at temperatures favorable for blighting the cell walls are penetrated with seemingly little resistance.

The chemical nature of the germinating embryos apparently depends upon the kind of building substances available and their proportion one to another. Because there is an abundance of dextrin and sugar, and relatively little available protein material in the wheat embryos grown at the low temperatures, these plants have thicker, more resistant cell walls. At the higher temperatures, however, there is more rapid vegetative growth with less dextrin and sugar available for building and thickening cell walls. Likewise, because of an abundance of sugar and fat available in the corn embryos at the high temperatures, a carbohydrate reserve exists for building thicker, more resistant cell walls.

(Cooperative investigations by the Wisconsin Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Poria cocus developed on tuckahoe found attached to orange tree root. GEORGE F. WEBER.

Several tuckahoes were found, in June, 1923, attached to the roots of an orange tree near Gainesville, Florida. They varied in weight from 5 to 9 pounds and were irregular in shape. The outside covering was bark-like, brown and tough. It varied from 3 to 8 mm. in thickness. The inner texture was white, starchy, spongy and gave off a mushroom odor. One of these bodies was sterilized for twenty minutes in a 1–1000 solution of corrosive sublimate. It was then carefully washed in five changes of sterile distilled water and placed in a sterile moist chamber at room temperature exposed to intermittent light. After ten days a chocolate-brown fungous growth appeared in several places on the outside covering, this growth matted down and fruiting structures developed of a resupinate nature apparently that of a Poria sp. The pores were irregular, 2 to 4 mm. deep, and of a distinct chocolate-brown color. The basidiospores were greyish white 6–9 × 2–4 μ.

Biological and cultural studies of Exoascaceae. I. Exoascus deformans (Berk.) Fuckel. A. J. MIX.

Isolations were made from ascospore-bearing leaves and from the interior of diseased leaves and stems. Single-ascus cultures were used for study. On solid media a slow-growing, yeast-like, delicately pink colony is formed. Cells formed in culture are: budding "conidia," short mycelia, and "resting cells." In their germination resting cells resemble ascogenous hyphae.

Minimum temperature for growth is below 10° C., optimum about 20° C., maximum between 26° and 30° C. Cultures are killed in a few days at 30° C. The thermal death-point is 46° C.

Cells from culture survive desiccation on glass at temperatures of 9°, 22°, and 30° C. for at least 140 days. The thermal death-point of cells in smears dried on glass is 100° C.

Limits of growth on potato dextrose agar and in potato dextrose broth are beyond pH 3.3 and pH 9.6. On the agar best growth occurred at pH 4.9. In general the acidity of the broth was increased, but in broth with an initial pH of 3.9, no change occurred.

Inoculations performed out of doors on buds previously sprayed with formaldehyde were successful. Cultures twenty-two months old proved virulent. Attempts to inoculate very young seedlings failed.

Biological and cultural studies of Exoascaceae. II. Exoascus mirabilis Atkinson. A. J. MIX.

Isolations were made from ascospore-bearing surfaces and from the interior of diseased shoots of *Prunus angustifolia*. The fungus grows well on various media. It cannot be distinguished by means of cultural characters from *Exoascus deformans*. Similar types of cells are formed in culture.

Limits of growth on potato dextrose agar are in the neighborhood of pH 2.6 and pH 11.2. Best growth occurred at pH 4.2. In potato dextrose broth, growth occurred at all concentrations tried between pH 10.45 and pH 3.28. No growth occurred at pH 10.90 and pH 3.06. Increased acidity occurred in all broth cultures except those with hydrogen-ion concentrations higher than pH 4.0; in these no change occurred.

Spraying dormant trees with lime-sulfur 1 to 20 prevents infection, indicating that some spore-form overwinters.

Sepal infection in relation to the seasonal development and control of apple scab. G. W. KEITT AND L. K. JONES.

Studies conducted during the last five years have shown that sepal infection bears very important relations to the seasonal development and control of apple scab, especially in seasons of severe outbreaks in early spring. Under Wisconsin conditions ascospores are ordinarily mature by the time the tips of the young leaves in the unfolding cluster buds are exposed to infection. The sepals are the first blossom parts so exposed and may be infected many days prior to the "pink" spray stage. Sepal infections establish the fungus on the young fruit in a most favorable position for early secondary infections. Such infections are much more injurious than those which develop later, and account for a large percentage of badly scabbed fruit. In our spraying experiments failure to control sepal infection has uniformly resulted in unsatisfactory control of the disease. A well timed "pre-pink" treatment with a suitable fungicide followed by the usual scab program has uniformly controlled the disease.

Seasonal development and control of apple scab and cherry leaf spot in relation to environment. G. W. KEITT AND L. K. JONES.

Comparative studies of apple scab and cherry leaf spot in Wisconsin have shown marked contrasts in their relations to environment. Although there was relatively little difference in the periods of ascospore discharge and in the time of exposure of susceptible host tissue to infection, there were marked contrasts in the seasonal development of the two diseases. In the case of apple scab, a low temperature disease, early discharges of ascospores commonly led to relatively abundant infection which established the fungus in a favorable position for secondary infection. The most critical period for the development of this disease was in the spring. It was retarded during the hot weather. Cherry leaf spot, a high temperature disease, made little progress during the cool period of early spring, but developed rapidly in early summer and attained its maximal development at summer temperatures. Accordingly, whereas it was formerly the practice in Wisconsin to make one pre-blossom fungicidal treatment for each of these diseases, it is apparent now that, under Wisconsin conditions, two pre-blossom treatments are necessary for satisfactory control of severe outbreaks of apple scab in early spring, while for cherry leaf spot the pre-blossom spray may be omitted.

Achyrodes aureum (L.) Kuntze, a host for many rusts. S. M. DIETZ AND I. W. CLOKEY.

According to Arthur, *Achyrodes aureum* (L.) Kuntze is susceptible to *Puccinia coronata* and *P. graminis*. The response of this gramineous host to the specialized forms of these rusts, however, was not determined. In studying the host range of the specialized forms of the crown-rust organism, *P. coronata*, *Achyrodes aureum* proved to be susceptible *A. aureum* was exposed to all available rusts. Spores were transferred from their natural hosts to *A. aureum*, thence again to their natural hosts. *A. aureum*, a low erect annual, belongs to the tribe Festuceae. Its vegetative growth closely resembles that of *Dactylis glomerata* Although indigenous to southern Europe, it has been introduced into many parts of the world, including Australia and southern California. *Achyrodes aureum* showed normal infection from uredospores of five specialized varieties of *Puccinia coronata*, namely: *P. coronata avenae*, *P. c. calamagrostidis*, *P. c. festucae*, *P. c. holcii* and *P. c. lolii;* two specialized varieties of *P. graminis: P. graminis avenae* and *P. phleum pratense;* and three other species: *P. dispersa*, *P. montanensis*,

and *P. poarum*. A subnormal infection was secured with two specialized varieties, *P. graminis secalis* and *P. g. tritici;* and with *P. triticina*. *Achyrodes aureum* is susceptible to several species of Puccinia and their specialized varieties. It affords excellent material for a study of specific parasitism.

(Cooperative investigations by the Iowa Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

An abortive sporophore of Sclerotium rolfsii. J. J. TAUBENHAUS.

The writer has made numerous attempts to produce a fruiting stage of *Sclerotium rolfsii* without success. This fall (1923) several watermelon fruits were inoculated with a pure culture of *Sclerotium rolfsii*. In four weeks the inoculated fruit were thoroughly decayed and a large amount of liquid was liberated and drawn off. Suddenly it was noticed that a small mushroom-like body made its appearance and this after ten days grew and developed into a typical fleshy mushroom. Examinations were frequently made of this sporophore which was found to be sterile. Bits of tissue of this growth were then plated out in petri dishes to determine whether it was a secondary infection or a sterile sporophore of *Sclerotium rolfsii*. Growth and minute mushroom-like bodies appeared in the petri plates, these, however, in turn being also sterile and after three weeks matured into typical sclerotia of *Sclerotium rolfsii*. From work, so far, it seems that this is a strain of *Sclerotium rolfsii* which is apparently capable of producing sporophores which for some reason or other have remained sterile. More research is in progress on this point.

Wheat bunt investigations in Kansas. C. O. JOHNSTON.

Studies on the resistance of several varieties of wheat to bunt have been conducted three years. In two of these years duplicate sowings were made. In one the seed was smutted with spores of *Tilletia laevis* and in the other with *T. tritici*. Hard winter varieties of the Turkey type, as a group, show considerable resistance to both species causing bunt. Those soft winter wheats adapted to Kansas conditions are much more susceptible to *T. tritici* than to *T. laevis*. This is shown by the table which was prepared from the 1923 data:

	Percentage of bunted heads, *T. laevis*.	Percentage of bunted heads, *T. tritici*.
Average of 20 hard varieties (Turkey type)	4.85	3.07
Average of 20 soft varieties	3.45	25.13

Varieties and hybrids from the Pacific Coast States, which are highly resistant under western conditions, show the same resistance to both kinds of bunt in Kansas. Of these, Red Hussar seems promising agronomically. Weekly sowings of a susceptible variety indicate that little infection takes place until the mean daily soil temperature has fallen to about 40° F. As the soil temperature falls below this point smut infection increases until a temperature of about 27° is reached. At both high and low temperatures the percentage of infection varies with the moisture content of the soil.

(Cooperative investigations by the Kansas Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Varietal resistance of winter wheats to Tilletia levis. G. H. COONS.

Results of two additional years' tests of resistance of winter wheats to *Tilletia levis* are now available. In the tests small samples of the various wheats were heavily dusted with *Tilletia levis* spores and planted about Oct. 15—the late planting insuring heavy infection by smut. The following table gives the per cent of smut in the crops as determined by head counts.

Variety	1922	1923
Shepherds Perfection	—	60%
American Wonder	53%	49
New Fultz	53	40
Illini Chief	53	—
Goens	50	46
Estes (240)	48	36
Poole	46	43
Estes (139100)	45	42
Michigan Wonder	44	—
Iowa 1946	—	40
Red Champion	39	19
Early Winter	39	47
Red Banner	39	26
Economy	35	46
New York 26	33	51
American Banner	31	55
Genesee 140900	30	66
Winter King	27	33
Lancaster 136200	26	42
Wonder	24	22
Red Rock	24	24
Lancaster 138700	23	27
Michigan Amber	22	30
Turkey	20	15
Banner American	19	0
Kharkof	15	9
Kanred (a)	12	0
Wisconsin Hybrid	11	21
Berkeley Banner	10	18
Genesee 141600	9	22
Turkey 138300	9	5
Kanred (b)	7.7	8
Alberta Red	6	7
Fultz 139400	4	6
Berkeley Favorite	2	0.8
Berkeley Rock 140200	1	1.6
Minhardi (Minn 1505)	1	—
Berkeley Rock 128700	0.6	0.3
Berkeley Rock 133300	0.4	0.4
Red Winter	0.2	—

Berkeley crossed with American Banner, Favorite, and Red Rock seems, to have given marked stinking smut resistance to its progeny. All the wheats, except Fultz, which have shown the strongest resistance to *Tilletia levis*, are Turkey wheats or selections from crosses with this type. The wheats resistant to *Tilletia tritici* recently reported in the literature are of similar origin.

Physiological studies on flag smut of wheat. MARION A. GRIFFITHS.

Experiments conducted by the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, show that spores of flag smut, *Urocystis tritici* Koke. kept in the laboratory were viable for at least four years. Spores overwintered in the soil at Granite City, Ill., were capable of infecting wheat. For infection in the greenhouse the optimum temperature was 20° to 23° C. Infection takes place most readily prior to emergence of the seedlings from the soil. Inoculated plants were clipped near the soil at three stages of growth. Clipping often increased the percentages of infection. Also, the interval between sowing and the appearance of infection often was shorter in the clipped plants. Fulcaster, Poole, Red May, Red Rock, Early Defiance, and Galgalos remained smut-free in the greenhouse during each of the three years of the varietal-resistance experiment. The percentages of infection shown by susceptible varieties grown in the greenhouse were considerably higher than those of the same strains grown in the field. Sowing inoculated seed at successive dates in the fall resulted in a general decrease in the percentages of infection up to November 14, when no infection occurred.

Puccinia graminis on Poa spp. in the United States. E. C. STAKMAN AND M. N. LEVINE.

Heavy infection of stem rust on *Poa spp.* in the United States was first observed in the fall of 1922 near Pontiac, Mich. Previous to this date *Puccinia graminis poae* was generally thought not to occur in this country. Several specimens of what appeared to be *P. graminis* on *Poa spp.* have been sent to the writers, but the amount of rust always was small and no infection was obtained from artificial inoculations. Abundant and heavy infection was produced on the common barberry when inoculated with teliospores from *Poa compressa* collected in Michigan. Aecial inoculation resulted in heavy infection on at least three species of Poa, but no infection on other grasses or on the cereals. In 1923, *Poa compressa*, near Pontiac, again was badly rusted. As a result of urediniospore inoculations, successful, normal infection was obtained on three additional species of Poa. Minute pustules were produced on barley also, but negative results were obtained on the other cereals and grasses. Measurements of the aeciospores, urediniospores, and teliospores of this specialized variety show it to be markedly different morphologically from any other specialized variety of stem rust.

(Cooperative investigations by the Minnesota Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Cytological evidence of physiologica ly distinct forms in Puccinia graminis tritici. RUTH F. ALLEN.

Stakman and Levine have proved the existence of physiologically distinct specialized forms of wheat stem rust. These forms, which are designated by number, are similar in morphology but differ in infecting power. Specialized form III grown on Kanred

seedlings in the greenhouse produces a fairly vigorous mycelium which fills intercellular spaces in the mesophyll, forms normal haustoria and "runners," and produces mid-size uredinia. Form XIX on Kanred can not form spores or even establish a mycelium. The fungus may die after forming the first haustorium, or may make several attempts before its strength is spent. Forms IX, XXI, and XXVII, grown on Khapli under parallel conditions, are similar in many respects, but differ in their effect on the stomata through which they enter the host, in the rate and extent of spread of the mycelium, in the modification of the haustorium mother cells of the fungus, and in spore formation. Changes induced by these fungi in the zone of tissue surrounding an infection vary as to the size of the region affected, the time of its appearance, the degree to which it is affected, the plasmolysis of its cells, and the staining reaction of its plastids.

(Cooperative investigations by the California Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Simultaneous surveys for stem rust: A method of locating sources of inoculum. E. M. FREEMAN AND L. W. MELANDER.

The use of simultaneous surveys of large or small areas to locate incipient local epidemics of stem rust and such common barberry bushes as may have escaped detection during the first surveys and resurveys is recommended. A study was made of the possibilities of simultaneous surveys in Minnesota in July, 1923. These surveys showed consistent differences in the rust severity in different localities of the district examined, although the rust epidemic was too far advanced to permit any correlation with the barberry as a cause of the differences. The use of winter rye and grass hosts as indicators in such surveys also is suggested.

(Cooperative investigations by the Minnesota Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Progress in barberry eradication. F. E. KEMPTON.

The barberry eradication campaign, conducted cooperatively for the past six years by the United States Department of Agriculture and thirteen north-central States, has progressed until approximately 656 counties have been surveyed. This includes a property-to-property survey of all cities and an inspection of all farms in these counties.

A summary of activities to October 31, 1923, shows a grand total of 9,726,348 common barberry bushes and seedlings found and 8,071,932 destroyed. During this season, 208,956 bushes and 1,706,027 seedlings were found in original survey and 215,366 bushes and 1,701,122 seedlings destroyed, while in resurvey of 299 counties, 102,066 sprouting bushes and 909,607 seedlings were destroyed.

Crushed rock salt proved the safest and most readily obtainable chemical for killing barberries. Over 400 tons were used. Sodium arsenite solution, while effective, proved dangerous to animals. Its use was discontinued. Kerosene and water-gas drip oil also are effective. Chemicals can not be applied safely near valuable trees or shrubbery.

A second survey of several previously covered counties showed plantings in each county not found on the first survey. In many counties these were sufficiently numerous to be responsible for initiating the rust epidemic of 1923. This shows the necessity of a second survey of some areas.

Studies in distribution and severity of rust, and resultant losses were continued. Local rust epidemics have enabled field men to find overlooked barberries.

Epidemiology studies with Puccinia coronata Corda. S. M. DIETZ.

Since 1916 aecidial infection of *Puccinia coronata* has appeared annually in Iowa on *Rhamnus cathartica* L. and *R. lanceolata* Pursh before uredosori developed on *Avena sativa*. The date of initial appearance of aecidial infection during these 8 years varied from April 30 to May 30. During 1923 many local crown-rust infections appeared on oats throughout the State previous to the general infection. Either *R. cathartica* or *R. lanceolata* was found near the center of each infected area. Infection varied from a trace on the edge of these areas to 30 per cent near the center. These infection areas developed simultaneously in northern and southern Iowa. All, at first small, remained constant 7 to 10 days, then expanded rapidly.

Eight hundred and twenty plantings of *R. cathartica* were found in representative areas in eight midwestern States. Of this number 188 were rural and 632 were urban. They contained 89,496 bushes, besides 34,018 feet of hedge of uncounted bushes. Over 80 per cent of all *R. cathartica* inspected bore crown rust aecidia. Nearly 100 per cent of rural plantings showed infection. In one area at Winthrop, Buchanan County, Iowa, oatfields adjoining a hedge of *R. cathartica* were destroyed by rust. Fields in adjoining sections yielded 10 bushels per acre while fields in more remote sections practically free from rust averaged 50 bushels per acre.

(Cooperative investigations by the Iowa Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

The rate of spread of wheat foot-rot in tillage plots in Kansas. L. E. MELCHERS AND M. C. SEWELL.

In 1921 wheat foot-rot was observed in tillage plots. The diseased areas were carefully plotted and their rate of spread has been recorded each season.

Continuous wheat culture 1911–1923	First appearance foot-rot	Average yield prior 1921	Yield 1923	Disease 1923
		bu.	bu.	
Not plowed; disked at seeding		6.4	2.5	None
Plowed Sept.; 3 inches (5 replications)		12.3	7.8	None
Double disked July; plowed Sept., 7 inches	1922	17.2	26.8	Very slight
Double disked July; plowed Aug., 3 inches	1922	17.9	17.2	Slight
Listed July; ridges worked down	1922	17.9	18.6	do
Listed July 15; ridges split Aug. 15	1922	17.4	9.2	Very bad
Plowed July; 6 inches	1921	19.2	12.7	do
Plowed Aug.; 6 inches	1921	18.4	6.0	do
Plowed Aug.; 7 inches worked Sept.	1921	17.6	18.9	Bad
Plowed Sept.; 7 inches	1923	13.1	10.4	Very slight
Plowed July; 3 inches		17.5	18.6	None

Ophiobolus cariceti (B. & Br.) Sacc. has been found on plants from various plots. Early, deep (6–7 inches) plowing or listing seems favorable for the development and

spread of foot-rot. **Late,** shallow (3 inches) plowing or disking inhibits it. Where wheat has been grown in rotation in adjoining land there has been no evidence of foot-rot.

(Cooperative investigations by the Kansas Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

New seed treatments for controlling stripe disease of barley. A. G. JOHNSON, R. W. LEUKEL, AND J. G. DICKSON.

During the past season certain new seed treatments for control of stripe disease of barley (*Helminthosporium gramineum* Rabh.) were given preliminary trials at Arlington Experiment Farm, Va., and Madison, Wis. Treated and untreated seed was sown in adjacent rod rows in triplicate. Treatments listed in following table controlled barley stripe perfectly and seed germination was not impaired.

Chemical	Concentration in water	Time
	Per cent	*Hours*
Semesan	0.3	1, 2
do	.6	½, 1, 2
Chlorophol	.2	1, 2
do	.3	½, 1, 2
do	.6	½, 1, 2
Germisan	.2	2
do	.3	½, 1, 2
do	.6	½, 1, 2
Corona No. 610	.2	½, 1, 2
do	.3	½, 1, 2
Corona No. 620	.2	1, 2
do	.3	¼, ½, 1, 2

Similar treatments with kalimat and formaldehyde solutions reduced the disease to a trace, while pythal solution and seed-o-san and copper carbonate dusts failed to control. Unfortunately uspulun was not available for these experiments. Rows from untreated seed averaged between 5 and 6 per cent stripe.

(Cooperative investigations by the Wisconsin Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Comparative efficiency of formaldehyde, copper-carbonate dust and sulfur dust in controlling smuts in hulled oats. R. S. KIRBY.

The following data were obtained from 19 experiments planted in 12 counties in New York State in 1923. Each experiment, consisting of 1 check and 2 to 5 treated plots, each of which averaged one-eighth acre in size, was planted with naturally inoculated oats from different sources. Seed treatments were usually made by county agents using identical materials. While the percentage of smut in the various check sections of the plots varied from .5 to 44.1 per cent, the percentage of smut eliminated by the various treatments was relatively the same.

Treatment	Average percentage of smut in checks	Average percentage of smut in treated plots	Percentage of smut eliminated by treatment	Odds compared with formaldehyde	Odds compared with 4 oz. $CuCo_3$
Formaldehyde (dry)	8.50	.442	95.56±1.82		14:1
Copper-carbonate dust					
(4 oz.) per bu.	10.90	1.50	88.10±1.82	14:1	
(2 oz.) " "	11.33	2.54	75.60±2.59	19,000+:1	116+:1
Dusting Sulfur					
(1 lb.) per bu.	15.80	5.18	59.10±5.11	19,000+:1	267+:1
(4 oz.) " "	9.54	5.40	49.58±8.81	1,350+:1	260+:1

Since significance can not be placed on odds less than 30:1 the tabulations show for the conditions of this experiment (1) formaldehyde is not with certainty a better treatment than 4 oz. $CuCo_3$, (2) formaldehyde is better than any other treatment excepting 4 oz. $CuCo_3$, (3) 4 oz. $CuCO_3$ is better than 2 oz. $CuCo_3$ or the sulfur treatments.

Water and lime-water baths following the formaldehyde seed treatment. W. H. TISDALE AND R. W. LEUKEL.

In Sweden, Henning (1919 and 1922) found that the injury caused to seed grain by the formaldehyde treatment was eliminated by rinsing the treated seed in water. In 1921, Zundel and Carroll recommended rinsing grain in lime-water following formaldehyde. The Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, is conducting experiments to determine the relative value of these methods. Spring-sown Kherson oats, soaked 10 minutes, 30 minutes, and one hour in formaldehyde (1–320), germinated in the soil slightly better when rinsed (soaked 10 minutes) in lime-water than when rinsed in water for the same period. In both cases rinsed seed germinated much better than did unrinsed treated seed and about as well as did untreated seed. The smuts were controlled satisfactorily with all the treatments. Fall-sown Winter Turf oats and Purplestraw wheat, when soaked 30 minutes in formaldehyde (1–320), gave approximately the same percentages of germination when rinsed in water as when rinsed in lime-water. The percentages of germination were about the same as those of untreated seed and much better than those of unrinsed treated seed. Either water or lime-water prevented a greater part of the injury.

Further studies on new seed disinfectants. W. H. TISDALE, J. W. TAYLOR, AND R. W. LEUKEL.

Since reporting on this subject in 1922, the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, has conducted further experiments with new seed disinfectants, including American and foreign products, to determine their relative effects on germination, vigor, and smut control of the small grains, as compared with the standard treatments. Of the dusts, copper carbonate, Corona No. 40-S, and Seed-O-San controlled bunt or stinking smut of wheat satisfactorily without injuring the seed. From the standpoint of yields, copper carbonate and No. 40-S were slightly better than copper sulphate-lime. None of the dusts has given entirely satisfactory results in the control of barley and oat smuts. Of the liquids, the organic mercury compounds, Chlorophol, Semesan, Corona No. 620, Uspulun, and Germisan,

have given good results in the control of barley and oat smuts. Germination and yields also were improved. Barley grown from seed treated with either Semesan or Chlorophol yielded better than did plants grown either from untreated seed of the same lots or from seed treated by any other method. For the control of barlet smuts results with these compounds have been more satisfactory than those obtained with either formaldehyde or hot water.

Fungicidal treatments for the control of sorghum kernel smut. C. O. JOHNSTON AND L. E. MELCHERS.

Seed of Blackhull kafir, Pink kafir, Red Amber sorgo and Kansas Orange sorgo, heavily smutted with *Sphacelotheca sorghi*, and treated with various fungicides, gave the following results:

Year	Percentage of	Formaldehyde: 1 pt. to 15 gal. 10 min.	Formaldehyde: 1 pt. to 30 gal. 30 min.	Formaldehyde: 1 pt. to 30 gal. 60 min.	Formaldehyde: Dry; 3 cc. per qt. seed; covered 5 hrs.	Corona No. 620 (1–500) soak 1 hr.	Chlorophol (1–300) soak 1 hr.	$CuSO_4$ 1 lb. to 4 gal. soak 15 min.	2 ounces per bushel of dry: Corona 40–S.	2 ounces per bushel of dry: Seed-O-San	2 ounces per bushel of dry: $CuCo_3$	Check
1921	Germination.	81.7	79.2	81.7								85.8
	Smut.	0.0	0.0	0.0								29.26
1922	Germination.	87.3	94.9	93.1	80.8	96.8	95.3	90.2	97.0	97.2		94.6
	Smut.	1.61	3.75	3.02	0.0	2.37	5.73	0.0	0.0	4.01		34.28
1923	Germination.	78.9	80.4	81.6	77.8	85.0	92.5	80.6	91.9	69.7	89.6	89.7
	Smut.	0.23	1.12	0.16	6.04	1.86	0.49	0.24	0.53	6.93	0.28	13.38
	Average germination.	82.6	84.8	85.5	79.3	90.9	93.8	85.4	94.4	93.4	89.6	90.0
	Average smut.	0.61	1.62	1.05	3.02	2.11	3.11	0.12	0.26	5.47	0.28	25.63

Slight seed injury occurs but satisfactory control of smut is obtained by soaking seed in copper sulphate or Chlorophol solutions, or by dusting with copper carbonate or Corona 40-S. Treatments conducted in various parts of Kansas indicate that copper carbonate dust is very promising.

(Cooperative investigations by the Kansas Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Experiments to show the effects of certain seed treatments on corn. CHAS. S. REDDY AND J. R. HOLBERT.

In general there was a decrease in resulting field stands and yields from seed treated with formaldehyde (1 : 240 for 30 and 60 minutes), calcium hypochlorite (1 : 28 for 3

and 6 hours), mercury bichloride (1 : 1000 for 30 and 60 minutes), or copper sulphate (4 pounds to 10 gallons for 2 hours) with and without lime dip. No detrimental effect and frequently an increase in stand resulted from the use of chlorophol (1 : 400 for 3 hours) on composites of corn seed designated as nearly disease-free, Fusarium-infected, Cephalosporium-infected, Diplodia-infected, and scutellum-rotted. The most marked effect was from the use of chlorophol on Diplodia-infected seed; field stands and yields were always increased, often as much as 30 per cent. However, the same treatment apparently decreased the yields of Cephalosporium, Fusarium, and scutellum-rotted composites, sometimes as much as 13 per cent.

Chlorophol (1 : 400), semesan (1 : 400), and corona 620 (1 : 1000), when used as treatments for 3, 4, or 5 hours, proved beneficial to stands and yields of nearly disease-free composites as well as Diplodia-infected composites.

(Cooperative investigations by Funk Brothers Seed Company and the Office of Cereal Investigations, Bureau of Plant Industry, United States Department of Agriculture.)

Second progress report on studies of corn seed germination and the prevalence of Fusarium moniliforme and Diplodia zeae. L. E. MELCHERS AND C. O. JOHNSTON.

Three years' germination studies with open pollinated Pride of Saline corn, corroborates the report made by the writers in 1922, that practically every ear of Commercial White and Pride of Saline corn has *Fusarium moniliforme* or *Diplodia zeae*, or both present. The latter organism varies in prevalence during different seasons, but the former is always abundantly present. The freedom of seed on the germinator from *F. moniliforme* does not seem as important in securing a satisfactory stand and yield of corn in Kansas as seedling vigor.

The following table shows results of germination of best ears which were selected for seed. These were taken from bin in 1920 and 1921 and from field in 1922. These data have been confirmed by cultures from hundreds of kernels representing large numbers of ears.

	Number of ears					Number of kernels			
Year	Tested	With *F. moniliforme* without *D. zeae*	With *D. zeae**	With all kernels diseased**	With less than half kernels diseased	Tested	With *F. moniliforme*	With *D. zeae*	Av. germination
									p. ct.
1920–21	703	410		699	4	7030	6980		98.2
1921–22	1500	1357	143	1499	0	15000	14989	548	98.4
1922–23	1200	1176	24	1042	34	12000	10501	51	99.5
Av. per cent.		93.8	6.1	94.1	1.2		94.1	2.2	98.7

(Cooperative investigations by the Kansas Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

* Also may have had *F. moniliforme*.

** *F. moniliforme* or *D. zeae* or both.

Common molds of corn seed in relation to yield. C. D. SHERBAKOFF.

The field experiments carried on by the writer at the Experiment Station, University of Tennessee, during the past two years, 1922 and 1923, show that corn seed when effectively treated against *F. moniliforme* does not give any better yield than the untreated seed of the same corn. To the contrary, the checks each year gave slightly better yield than the treated seed. The experiments were thoroughly checked up each year and the results of the first year are entirely in the agreement with results of the second year. The conclusion is that, under the conditions of the experiments, corn seed contamination with the mold has no effect on the yield. This situation may be due to either the non-pathogenic nature of *F. moniliforme*, in respect to corn roots, or that soil contamination with the fungus is so thorough and effective that seed freedom from it is of no consequence.

Relation of internal cob-discoloration to yield in corn. R. A. JEHLE, F. W. OLDENBURG, AND C. E. TEMPLE.

The butts and tips were chopped off from selected seed ears. Then, these ears were divided into at least two lots; those with distinct internal cob-discoloration, and those apparently free from internal cob-discoloration. Plots grown from each lot showed an apparent correlation between internal cob-discoloration and yield in corn which was more pronounced on light sandy and poor clayey soils than on the best corn land. This is indicated by the following table:

Year		No. of Tests	No. of counties	Average yield from corn on discolored cobs	Average yield from corn on cobs with no color	Average increase bushels	Average increase per cent
1921	Total	6	4	39.57	51.46	11.89	23.1
1922	Total	39	16	57.86	67.19	9.33	16.12
1923*	Total	15	8	65.25	58.33	6.92	11.86
1921	Very good corn land	1	1	60.4	63.3	2.9	4.8
1921	Medium to poor land	5	4	35.41	49.13	13.72	38.77
1922	Very good corn land	9	3	84.16	88.81	4.65	5.5
1922	Medium to poor land	30	15	51.39	60.86	9.47	18.43
1923*	Very good corn land	3	2	78.25	80.25	2.00	2.55
1923*	Medium to poor land	12	8	53.35	61.25	7.9	14.8

* Record incomplete.

Studies on seed infection, ear types, and yield, and the isolation of strains of corn showing specific disease reactions in the germinator. W. D. VALLEAU.

If germination tests of properly cured ears of corn are conducted in a sand box in a warm room, it will be found that the plants eventually die due to a rot starting at or

near the seed. The average time of death of the plants from a given ear may differ widely from that of other ears. In general the roughest ears produce the earliest dying plants. Selection of the extreme ears, i.e., those producing early dying and those producing late dying plants in the sand box, has given practically no differences in yield under field conditions, the "severely diseased" ears being as high producers as those which would commonly be called "disease-free." Selection for the extremes of smooth ears and rough ears from 500 and 700 ears of Boone County White in 1922 and 1923, respectively, resulted in increases of 39.43 and 13.9 per cent in yield for the smooth types over the rough. Studies on seed infection, both microscopically and by culturing, have shown that the seeds of the apparently most disease-free ears are quite heavily infected with fungi. By continued self-pollination, strains of corn have been isolated which have distinct disease reactions in the sand germinator, some being characterized by short life and others by long life.

Studies on the Diplodia disease of corn. J. R. HOLBERT, BENJAMIN KOEHLER, AND G. H. DUNGAN.

During the past five years experiments have been conducted in various parts of Illinois with yellow dent corn grown from seed infected with *Diplodia zeae* (Schw.) Lev. in comparison with corn from nearly disease-free seed. Reduced field stands and lowered vigor of surviving plants have resulted from the infected seed. Plantings made early in cool soils were reduced to 20 to 30 per cent stands from infected seed, compared with 88 to 92 per cent stands from nearly disease-free seed. Plantings with Diplodia-infected seed made later in warm soil high in moisture also resulted both in field stands and vigor of surviving plants being greatly reduced, while in similar plantings in warm, comparatively dry soil field stands from infected seed were reduced only to 80 to 85 per cent in comparison with 94 to 98 per cent stands from nearly disease-free seed.

Mature plants from Diplodia-infected seed showed less resistance to a vertical pull than those from disease-free seed.

Both open-fertilized and inbred strains of corn have been found to differ greatly in their resistance to the Diplodia disease.

In 1923 seed treatment for 3 hours in a 1 to 400 water solution of chlorophol increased the yield of corn from Diplodia-infected seed 30 per cent.

As an average of more than 40 experiments in central Illinois, neither lime nor phosphates gave a significant increase in yield with corn from Diplodia-infected seed.

(Cooperative investigations by the Illinois Agricultural Experiment Station, Funk Brothers Seed Company, and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Corn resistant to rust, Puccinia sorghi. E. B. MAINS, F. J. TROST, AND G. M. SMITH.

Approximately 2,800 one-, two-, three-, and four-year selfs of 15 varieties of sweet corn and 5 varieties of dent corn, which are being studied in corn root-rot investigations, also were studied in the greenhouse for their susceptibility to rust during the winter of 1922–23. Many different types of susceptibility were found, ranging from almost complete immunity and a number of different degrees and types of resistance, to more or less high degrees of susceptibility. Resistant individuals were found in the following varieties of sweet corn: Stowell's Evergreen, Early Evergreen, Narrow-Grained Evergreen, Country Gentleman, Goldenrod, Golden Bantam, Howling Mob, Early White-Cob Cory, Kendel's Early Grant, Black Mexican, and several hybrids. In the dent

corns, resistant individuals were found in the varieties, Silver King, Golden Glow, Early Yellow Dent, Johnson County White, and Darke County Mammoth. Most of the self showing resistant individuals evidently were heterozygous for this character. A few, however, were found which evidently were homozygous for resistance.

(Cooperative investigations by the Purdue University Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Wheat resistant to mildew, Erysiphe graminis. E. B. MAINS.

About 650 strains of wheat were tested in the greenhouse as to their susceptibility in the seedling stage to powdery mildew. These strains included a large number of the varieties most commonly grown in the United States, including varieties of durums, emmers, spelts, einkorn, club wheats as well as winter and spring varieties of the common bread wheats. Of the latter, Norka, Chul, Huron, Red Fern, Sonora and one strain of Michigan Amber were especially resistant, being practically immune to the mildew. Among the other wheat species Khapli, Vernal emmer, and einkorn were the outstanding varieties.

A bacterial disease of broomcorn and sorghum. CHARLOTTE ELLIOTT AND ERWIN F. SMITH.

Bacterium andropogoni E. F. S. produces, on many varieties of sorghum and broomcorn, red lesions a few millimeters in diameter and extending as long streaks through leaf blades or sheaths. Abundant exudate dries down forming red crusts or scales. While lesions are similar in form on different varieties, color varies from deep reddish brown or purple to orange red. Lesions on a few varieties show no reddening. This color is not marginal as in many sorghum spots but continuous throughout lesions.

Isolations from broomcorn, sorgo, grain, and grass sorghums have all given the same type of organism, the pathogenicity of which has been proved by repeated inoculations and reisolations. No natural infections have been found on Sudan grass but inoculations have produced typical, dark red streaks very different from the common leaf spot of Sudan grass. The same type of lesion also has been produced artificially on a Feterita-Milo hybrid.

Sorgos appear to be most susceptible, grass sorghums most resistant and grain sorghums intermediate. There also are considerable differences in varietal resistance in each group. Attempts to extend the host range to corn and millets have not been successful.

(Cooperative investigations by the Laboratory of Plant Pathology and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Further investigations on the pasmo disease of flax. W. E. BRENTZEL.

The disease of flax caused by *Phlyctaena linicola* Speg., called "pasmo" in South America, has recurred in North Dakota with considerable severity during the past season. It occurred also in South Dakota, Minnesota, Wisconsin, and Michigan. Authentic specimens from South America were examined and the fungus found identical with that in this country. In Michigan fiber flax was ruined where severely attacked and seed flax at Fargo, N. Dak., was damaged somewhat by blighting of the stems, leaves, and capsules. Large brown lesions developed on the individual plants. At

Fargo, N. Dak., these changed to an ashy gray color in the late stages of infection. The lesions often had the appearance of being pubescent due to the presence of numerous white spore-tendril or spore-horn forms in which the pycnospores issued from the pycnidia. These spore-horns were bent or coiled and measured about 10 to 25 by 65 to 450 microns. Microscopic examination of sections through lesions have shown the pycnidia extending to the region of the bast fiber cells. In plats of fiber flax which were grown at East Landsing, Mich., by Mr. L. R. Davis, plants developed the disease most severely when the seed came from infected sources. Some varieties of both seed flax and fiber flax were more resistant than others.

(Cooperative investigations by the North Dakota Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Observations on malformed tassels of teosinte plants infected with downy mildew. J. H. CRAIGIE AND WM. H. WESTON, JR.

Of the many plants of teosinte (*Euchlaena mexicana*) heavily infected with *Sclerospora philippinensis* after inoculation as seedlings in the Philippines, several successfully matured; and some of these developed strikingly malformed tassels. These inflorescences were preserved, and their structure as now studied in comparison to that of healthy plants, shows certain points of pathologic interest. The spikelets are invariably sterile; since the stamens are usually lacking entirely, or if rarely present, have withered anthers containing few non-functional pollen grains of abnormal size, shape, and content. Moreover, the glumes and lemmas show astonishing overgrowth, often to six times normal size, and are contorted, wrinkled, and tightly enwrapped. Rarely, the normally paired florets within the spikelets show proliferation to as many as seven. Also, from the base to the tip of the rhachis there is a progressive reduction in the component parts of the spikelets. The abnormalities shown by these teosinte tassels present an interesting comparison to those that have been described in the case of inflorescences of maize, wheat, rice, millet, and other grasses as a result of infection by other Sclerosporas.

Fusarium culmorum in Oregon, its varieties and strains that cause disease of cereals and grasses. JESSIE P. ROSE.

Isolation of *Fusarium culmorum* and its strains from cereals grown in different sections of Oregon, inoculation experiments, study of cultures upon different media at the Oregon State Experiment Station (1918–21), and in Wisconsin (1921–23), together with studies and determinations made by C. D. Sherbakoff show; that there are present in Oregon, *Fusarium culmorum*, *F. culmorum* var. *leteius*, and at least two other distinct varieties and one strain, (descriptions not published); that although these Fusaria have the color characters of *F. culmorum* and *F. culmorum* var. *leteius*, there are certain morphological and physiological characters and host relationships that differentiate them; that all of these Fusaria will cause disease of Triticum, but in varying degrees; that *Fusarium culmorum* and closely allied forms cause disease of Triticum and Avena, but certain strains seem to attack Avena more severely; that the variety, *F. culmorum* var. *leteius* will cause disease of Triticum, Avena, Zea mays, Secale, Hordeum, and grasses belonging to the genera Agropyron, Arrhenatherum, Avena, Elymus, Hordeum and Lolium, but Triticum and Avena seem to be the preferred host genera. These studies show that *Fusarium culmorum* may not only contain distinct varieties, but suggest that it may also contain distinct biological strains.

Fusarium culmorum var. leteius, a cause of disease in cereals and grasses. JESSIE P. ROSE.

In cereal investigations at the Oregon State Experiment Station, during 1918–21, *Fusarium culmorum* var. *leteius* Sherbakoff, was isolated from diseased plants of wheat, corn, oats, barley, Italian rye grass, from wheat seed rarely, and from the soil of infested fields, which represented the principal sections of Oregon. In extensive inoculation experiments conducted in the laboratory, greenhouse, and field, this Fusarium was found to cause blighting of wheat seedlings, diseased conditions of mature plants, a reduction in stand, and decreased yield.

Controlled temperature and moisture studies in the greenhouse, and field-temperature studies in Wisconsin during 1921–23 show that in addition to causing diseased conditions of spring and winter wheats, this Fusarium will cause seedling blight and diseased conditions of mature plants of barley, oats, rye and grasses belonging to the genera, Agropyron, Arrhenatherum, Avena, Elymus, Hordeum and Lolium. The percentage of blighting and severity of the disease depending upon the condition of the seed and environmental factors, particularly temperature and moisture. In controlled inoculation experiments, it was found that this Fusarium will cause severe scab of wheat.

Experiments with dusting and spraying for the control of tobacco wildfire in seed-beds. JAMES JOHNSON.

The extent of the damage caused by wildfire in the field is largely dependent upon the weather conditions prevailing. According to observation and experiments a small percentage of infection on the seedlings may eventually cause a comparatively heavy field infection. The application of copper-lime dusts and Bordeaux mixture sprays is not believed to reduce plant-bed infection sufficiently in most cases to overcome the damage which may result from the transplanting of slightly diseased plants. Our experience has not gone far enough, however, to imply that dusting or spraying may not be beneficial under certain conditions.

The effectiveness of copper fungicides against the wildfire bacteria does not seem to be due to the copper they contain. Certain calcium compounds seem to be equally effective in preventing wildfire infection. It seems likely that dusts and sprays are in part beneficial because of the mechanical barrier they offer to infection.

Disinfection of tobacco seed against wildfire. JAMES JOHNSON AND H. F. MURWIN.

Formalin and corrosive sublimate treatments have been recommended for disinfecting tobacco seed against the wildfire organism (*Bacterium tabacum*). Both of these treatments have proven to be injurious to germination under certain conditions. Corrosive sublimate treatment results in practically complete prevention of germination of tobacco seed where sprouting before sowing is practiced, although no appreciable injury occurs where seed is sown directly in the soil or is tested for germination on filter paper. Corrosive sublimate cannot be recommended, therefore, in districts where growers sprout their seed before sowing.

Modifications of the above methods, as well as several other methods, have been tried without giving the desired results. Silver nitrate treatment (1–1000) for fifteen minutes, however, gave better disinfection than formalin treatment and equally as good disinfection as corrosive sublimate. No injury to the seed follows silver nitrate disinfection by any method of sprouting practiced by growers. Doubling the strength or

time of treatment or omitting rinsing in water after treatment produced no injury. Silver nitrate seems therefore to be an ideal disinfecting agent for tobacco seed.

Angular leaf-spot and wildfire infection of tobacco plant beds by spitting. W. D. VALLEAU AND CHARLES HUBBARD.

Angular leaf-spot and wildfire infection usually did not occur in tobacco plant beds in Kentucky until after weeding. Angular leaf-spot was very prevalent the past spring, being found in over 90 per cent of the plant beds examined. Chewing the natural leaf from the previous year's crop is a habit common to about 90 per cent of tobacco growers in Kentucky. Various investigators have shown that the organisms causing these two diseases are capable of living over winter in the cured leaves. Experiments conducted during September 1923 in tobacco plant beds located outside have demonstrated that wildfire and angular leaf-spot may be introduced into the plant bed by chewing leaves infected with one or the other of these diseases and spitting the material on the young plants in the bed. The leaves used were air-cured and from the current season's crop. Seed treatment, supplemented by the usual sanitary precautions, has not resulted in control under farm conditions. It is believed that chewing tobacco is the chief source of plant bed infection in Kentucky, and that attention to this source, supplemented by seed-treatment and proper selection of seed-bed site to prevent the introduction of tobacco trash will result in complete control in the plant bed. It is possible that the distribution of commercial tobacco may explain the rapid world distribution of wildfire since its discovery in 1917.

Progress report upon the resistance of commercial strains of tobacco to root-rot. C. R. ORTON AND OTTO OLSON.

Thirteen distinct strains of Pennsylvania Broadleaf and Havana types of tobacco have been tested for their reaction to root-rot, attributed to *Thielavia basicola*, on severely infested soil under field conditions during the past four years. Three of these strains, Hibshman, Leaman and Olson which are of the best commerical types have been found to be highly resistant to this disease as well as two other strains which are of less commercial importance in Pennsylvania. Attention is called to a unique plan of field tests by means of which the variable factors of soil environment are reduced to the least error.

Progress report on Phytophthora-resistant tobacco. W. B. TISDALE.

During the last two years black shank, caused by *Phytophthora nicotianae* Van Breda de Haan, has been recognized as the most serious disease of tobacco in the Florida-Georgia district. The causal organism inhabits the soil and persists at least five years after infested land has been abandoned for tobacco culture. It attacks the roots and lower portions of stems and lower leaves of tobacco in any stage of development. The disease may cause a 50 per cent reduction in yield the first year it appears in a field, depending upon the variety of tobacco and its stage of development when first attacked. Connecticut Round Tip appears to be completely susceptible to the disease, while Big Cuba, the common Florida variety, is more resistant.

In 1922 seed was saved from several healthy Big Cuba plants in badly diseased fields. Progeny of these mother plants were tested on infested soil in 1923 and a few of them showed a high percentage of resistance to black shank, as shown in the following table:

Strain	No. of plants	Diseased per cent	Living per cent	Yield per Acre pounds
E-22-2	431	26	95	900
P-22-3	112	19	95	960
E-22-14	400	24	93	1,080
Big Cuba, check	520	82	77	480

Studies of anthracnose infection in cotton seed. C. A. LUDWIG.

Cotton seed which is badly infested with the anthracnose fungus and spores gradually becomes clean after being stored for a considerable time. Thus it is perfectly safe to use it for planting the third spring after gathering if stored under laboratory conditions and is practically safe the second spring. The greatest reduction in infection occurs during the autumn when the seed is about a year old. Seed kept in a moist atmosphere cleared up more rapidly than other seed, but became musty and ceased to germinate. Seed stored in a uniformly very dry atmosphere remained very heavily infected for over two years. Alternating between a very moist and a very dry atmosphere reduced the infection somewhat more rapidly than ordinary storage and did not permit a great amount of mustiness to develop. Storage in laboratory conditions appeared to be slightly more favorable to the dying out of the fungus than storing under an open shed in conditions comparable to those usually available to farmers. Preliminary heating or drying by ordinary methods did not help appreciably. Delinting with sulphuric acid, followed by sterilizing with mercuric chloride reduced infection very much but did not eliminate it.

Chestnut blight in Europe (Endothia parasitica (Murr.) A. & A.). HAVEN METCALF.

The occurrence of chestnut blight at Bruges, Belgium, is reported. It is believed that this is the first report of this disease in Europe. In London a chestnut staging-pole was observed with a blight canker on it, but the fungus was dead. The theory is advanced that the chestnut blight may have been taken to Europe from America on chestnut poles or other chestnut timber during the war.

Observations on the Douglas fir canker (Phomopsis pseudotsugae Wilson) in Great Britain. HAVEN METCALF.

During the last twenty years great numbers of American Douglas Fir (*Pseudotsuga taxifolia* (Poir.) Britt.) have been planted in Great Britain, particularly in Scotland; and especially since the war, which gave a great stimulus to reforestation. The tree is planted mostly in pure stands. In many places the Douglas fir canker has assumed a serious aspect. It was seen by the writer at various points from Exeter, England, north to Loch Awe, Scotland, and probably occurs throughout the British Isles wherever Douglas Fir is planted. At least until its origin is determined, this disease must be regarded as a dangerous potential enemy of the Douglas Fir forests of America. It has not yet been found in America nor on the continent of Europe.

Wind dissemination of aeciospores of Cronartium ribicola Fischer. L. H. PENNINGTON.

Field studies upon the white pine blister rust were carried on for the U. S. Department of Agriculture during the seasons of 1922 and 1923 in the Pacific Northwest. These studies indicate that the rust in this region originated from infected *Pinus strobus* which was imported in 1910 from France into Vancouver, British Columbia.

The rust has spread widely. It has been found upon Ribes at the north 110 miles beyond the limits of white pine, at the south to the mouth of the Columbia River, and at the east across the Dry Belt upon both pines and Ribes from 150 to 200 miles from infected pines in the Coast region. This Dry Belt, 150 miles wide with no white pines, separates the eastern and western belts of white pine in British Columbia.

It has become increasingly evident that the extensive distribution of the rust has been caused by wind-born aeciospores. At long distances from the source of aeciospores, infection has been found most frequently upon the cultivated black currant, *Ribes nigrum*. This emphasizes the fact that in the Northwest as well as in other regions *Ribes nigrum* is a most dangerous host for the spread and establishment of white pine blister rust.

Survey of blister rust infection on pines at Kittery Point, Me., and the effect of Ribes eradication in controlling the disease. G. B. POSEY AND E. R. FORD.

In 1916 the white pine blister rust (*Cronartium ribicola* Fischer) was found to be epidemic on native white pines (*Pinus strobus* L.) at Kittery Point, Maine. From 1917 to 1921 field studies were made upon the epidemiology and local control of the disease on this severely infested area. The principal damage occurred on pines growing within 900 feet of a patch of cultivated black currants (*Ribes nigrum* L.). Local storm winds influenced the direction of spread of the disease and its concentration on pines varied with the size and dominance of the trees and the density of the stand. Complete eradication of Ribes in 1917 prevented any further infection on the pines and in five years has permitted natural restocking with healthy pine seedlings at the rate of 242 trees per acre.

Controlling white pine blister rust in the Northeastern States. E. C. FILLER.

Practical control of the white pine blister rust is being accomplished in the Northeastern States by systematically eradicating wild and cultivated Ribes spp., growing within infecting range of white pine stands. Under average field conditions this distance does not exceed 900 feet. Land owners or crews of laborers can do the control work effectively under trained supervision and leadership. In 1917 the U. S. Department of Agriculture in cooperation with the infested states initiated a general control program for preventing serious damage to the white pine crop in infested regions. Since then Ribes have been destroyed on approximately two and one half million acres of land growing white pine. Efficiency checks on areas worked show that more than 95 per cent of the Ribes were found and eradicated. The average per acre cost of this work has been reduced from 72 cents in 1918 to approximately 20 cents in 1923. Recent surveys of control areas worked several years previously show that Ribes eradication has been effective in preventing further commercial damage to the pines.

Hypoxylon poplar canker. ALFRED POVAH.

(Abstract in Phytopath. **12**: 59. 1922.)

Wound healing of mesophytic leaves. ROBERT B. WYLIE.

Numerous layers of mesophyll cells, which collapse and die when exposed by wounding, constitute the initial protection to the cut edge of the leaf. This false cicatrice is sup-

plemented in *Vitis vulpina* by the infolding of the epidermal layers over the wounded edge, and in *Rhus glabra* by the latex poured out in the region of larger veins. Mitoses begin in two or three days but the healing process is not completed in these leaves for nearly two weeks. The cicatrice consists of several layers of cells which are tightly fitted together building a cork-like tissue across the wounded edge of the leaf. The walls of these cells are considerably thickened, and the cells have modified content. Lignin may be demonstrated within 24 hours after wounding, and it persists indefinitely in the cicatrice. All cell layers of the normal leaf take part in the formation of the cicatrice, but the epidermal cells of such mesophytic leaves seem to divide but once while in some xerophytes a single epidermal cell may give rise to many cells of the cicatrice. Since infection so seldom follows leaf wounds it seems that both the temporary and the permanent cicatrice are efficient in protecting the leaf from fungi.

Insect transmission of aster yellows. L. O. KUNKEL.

During the time of most rapid spread of the aster yellows disease in experimental plots at Yonkers, N. Y. the tarnished plant bug *Lygus pratensis* L. and the leaf-hoppers *Cicadula sex-notata* Fall. and *Empoasca unicolor* Gill. were present in abundance. A third leaf-hopper *Graphocephala coccinea* Forst. was present but rather rare. Aphids were occasionally observed but were never abundant.

Experiments in which the tarnished plant bug and the leaf-hoppers *Empoasca unicolor* and *Graphocephala coccinea* were transferred from diseased plants to healthy young plants in insect-proof cages gave in all cases negative results and suggest that these insects do not spread the disease. Similar experiments in which *Cicadula sex-notata* was used, show that this leaf-hopper readily transmits aster yellows. By using a non-infected culture it was shown that the insect is capable of transmitting yellows only after feeding on diseased plants. It is believed that *Cicadula sex-notata* is responsible for most, if not all, of the spread of aster yellows in the vicinity of New York City.

A flagellate infection of milkweeds in Maryland. FRANCIS O. HOLMES.

Typical herpetomonad flagellates occur in the latex of plants of *Asclepias syriaca* Linnaeus in the vicinity of Baltimore, Maryland. The infections are very heavy; in the freshly drawn latex active movement is easily observed. Dividing forms may also be seen.

In size and morphological characteristics the organism agrees with the description of *Leptomonas Elmassiani* Migone, a small form, found in 1916 in Paraguay. This name should now be *Herpetomonas elmassiani* for the two genera were united under that name by Bütschli (1884). Near Baltimore *Oncopeltus fasciatus* (Dall.), a common red and black hemipterous insect frequenting the infected colonies of milkweed, is under suspicion as the transmittor, since the flagellates in its intestinal contents closely resemble those in the plants.

In infected milkweeds the flagellates reach all parts except the roots and seeds. The plants are yellowed and the smaller pods are frequently shrivelled. Whether or not this is due to the flagellosis requires further investigation. Pictures of the flagellates drawn to scale are presented herewith.

(Joint contribution f om the laboratories of the Thompson Institute for Plant Research and of the Department of Medical Zoology, School of Hygiene, Johns Hopkins University.)

Mosaic cross-inoculation studies. OTTO H. ELMER.

Mosaic of plants is transmissible between hosts belonging to distinct orders and families. Such infection has been secured under controlled conditions by artificial inoculations and through the agency of insects. Successful infections of mosaic have been secured to *Nicotiana tabacum* from the following hosts:
Cucumis sativus, Cucurbita moschata, Phaseolus vulgaris, Abutilon theophrasti, Zinnia elegans, Calendula officinalis, Stokesia laevis, Asclepias syriaca, Rubus sp. (Red raspberry), *Martynia louisiana, Euphorbia preslii, Aquilegia canadensis, Apium graveolens* and *Saccharum officinarum;* to *Lycopersicum esculentum* from: *Abutilon theophrasti, Zinnia elegans, Calendula officinalis, Asclepias syriaca, Nepeta cataria, Martynia louisiana, Apium graveolens* and *Saccharum officinarum;* to *Vigna sinensis* and *Soja max* from *Cucurbita moschata;* to *Cucurbita moschata* from *Lycopersicum esculentum;* to *Vigna sinensis* from *Solanum melongena;* and to *Martynia louisiana* from *Nicotiana tabacum.*

With bean and sugar cane mosaic, artificial infections to tobacco and to tomato have been secured only when inoculations were made with mosaic tissue mascerated in a solution of acetone. This chemical has not been an aid in other crosses.

Artificial infections are generally more difficult and the incubation period is usually longer in cross-inoculations between families than is the case within the family. For successful artificial infection between families it is necessary that a vigorous growing condition is present not only in the inoculated plants but also in the plant from which the inoculum is taken.

Transfer of mosaic disease from red to black raspberries. RAYMOND B. WILCOX AND FLOYD F. SMITH.

By placing aphids (*Amphorophora rubi* Kalt.) from healthy raspberry plants upon leaves of King red raspberries affected with mosaic disease, allowing them to feed for a few days, then transferring them to young tip leaves of healthy Kansas black raspberries, symptoms have been induced in the latter which have frequently been noted in the field.

Tips of the black raspberries wilt and usually die to a distance of from one to three inches from the terminal bud; the green color of the next leaf fades, beginning at the base, and leaves a somewhat mottled appearance; this symptom then appears in other leaves progressively down the stem; growth of the plant is retarded.

Black raspberry plants upon which were placed aphids of the same species from healthy raspberries remained apparently healthy. The symptoms were not induced by aphids of other species.

These experiments have been performed both in the field and greenhouse.

Cytological studies on tobacco mosaic. T. E. RAWLINS AND JAMES JOHNSON.

Cytological studies on tobacco mosaic, using Haidenhain's iron-alum haematoxylin stain with best results, demonstrated the occurrence of at least three distinct abnormal cell inclusions in chlorotic tissue. Among the first abnormalities to appear after inoculation is a mass of yellow-staining striate material which radiates from the nucleus. In young leaves the cytoplasm of the same cells usually contain one or two small black staining bodies about the size of the nucleoles. In some of the cells of older leaves as many as twelve bodies of this same type were observed. Vacuolate bodies varying in size from those just visible to slightly larger than the nucleus occur adjacent to the nu-

cleus at first, but appear to increase in size and become detached from it later. The early stages of the vacuolate bodies found in the glandular trichomes often contain a black staining central granule.

With the exception of the type in which a single cell contains numerous small, black-staining bodies, all of the above types have been found in dividing cells. The body apparently passes to one of the daughter cells during the division.

Temperatures which inhibit the development of mottling also inhibit the development of these bodies.

No conclusion has been reached as to whether these abnormal bodies are concerned with the cause or the result of the mosaic disease.

Physalis and cucurbit mosaic intertransmissible. M. N. WALKER.

Inoculations during the past year indicate that the mosaic diseases of physalis and cucumber are intertransmissible. An annual species of cultivated ground-cherry (*Physalis pubescens* ?) was used in these inoculations. The occurrence of a considerable number of mosaic wild perennial physalis plants, (*P. heterophylla* and *P. subglabrata*) in the vicinity of mosaic infected cucumber fields indicates that physalis is concerned in the overwintering of cucurbit mosaic. Preliminary inoculations from mosaic plants of these species have borne out this belief. The favorable results obtained by the eradication of physalis in experiments on the control of cucurbit mosaic also indicate that it is an important source of infection to the cucumber although these results were somewhat complicated by abnormal seasonal conditions. The cultivated physalis has also been found susceptible to pokeweed mosaic and has served as an intermediate host in inoculations from mosaic tomatoes to the cucumber. Physalis has proven especially valuable in the latter experiments since it is a host plant for aphids from both the cucumber and tomato. A complete report of this work will appear at a later date

Experiments on the control of cucurbit mosaic. S. P. DOOLITTLE AND M. N. WALKER.

Continued investigations indicate that cucurbit mosaic overwinters on the pokeweed, *Phytolacca decandra* and on *Physalis* spp. in addition to the milkweed, *Asclepias syriaca*, and wild cucumber, *Micrampelis* (*Echinocystis*) *lobata*. Their importance varies with the locality. All excepting the pokeweed are found in Wisconsin and northern Illinois. Mosaic pokeweeds occur in Michigan and Indiana and appear to be the chief source of infection in southern Illinois. In field experiments on the control of mosaic through the eradication of wild host plants at Rockland, Wis., during 1923, mosaic Physalis appeared to be the chief source of infection. These experiments included ten fields which in preceding years had been from 30 to 100 per cent mosaic. During 1923, nine of these fields averaged less than one per cent mosaic on September 1. The remaining field was infected early in the season, despite eradication, and showed 70 per cent mosaic, indicating that seasonal conditions were not such as to prevent the development of the disease. At Madison, Wis., the milkweed appeared to be the source of infection in a field which has been in use for experimental work for the past six years and has been 100 per cent mosaic each season. Following eradication, this field showed only 6 per cent of mosaic on September 1, although surrounding fields suffered severely. Preliminary experiments in southern Illinois indicated that eradication of the pokeweed also gave apparent control of the disease.

The mosaic disease of Nicotiana glutinosum not distinct from tobacco mosaic. M. N. WALKER.

The inoculation of healthy plants of *Nicotiana glutinosum*, the *N. viscosum* of Allard's paper, "A specific mosaic disease of *Nicotiana viscosum*," with tobacco mosaic resulted in infection in a large number of cases. Controls remained healthy. It was found also that the mosaic disease of *N. glutinosum* as occurring at Madison, Wis., is transmissible to tobacco. Toward the end of the growing season it was found that infection was less readily secured or that the symptoms were so masked on *N. glutinosum* plants as to prevent accurate diagnosis. This fact may account for the negative results given in the paper mentioned. Although Allard's results suggest the existence of two types of mosaic disease within the single genus Nicotiana, the present work indicates the probability of the existence of but a single type. A full report of these results will appear in a later paper.

The relation of Chenopodium murale to curly-top of the sugar beet. EUBANKS CARSNER AND C. F. STAHL.

Many of the beet leafhoppers which come into the beet fields in spring are non-viriferous. *Chenopodium murale* is one of this insects' winter host plants. Inoculations have shown that this plant is very resistant to curly-top. Tests with nymphs reared on this plant from viriferous parents have indicated that usually the virus of curly-top is so attenuated by its passage through this resistant plant that it subsequently fails to cause the disease or else produces only mild cases. It seems probable that the non-viriferous leafhoppers which enter the beet fields in spring come from *Chenopodium murale* or plants comparable to it in relation to curly-top. Studies are in progress to determine whether or not the attenuated virus can be reactivated.

Experiments with inoculated sulphur for scab control. JULIAN G. LEACH AND R. C. ROSE.

Experiments have been conducted for two years at various points in Minnesota on a wide variety of soil types, including peat. The results obtained were very variable. In a few cases an appreciable reduction in the amount of scab was obtained but in the majority of cases little or no control could be detected. In many places the application of inoculated sulphur resulted in a decreased yield without any appreciable reduction in the amount of scab. The particular type of soil on which the sulphur is applied appears to have a great deal to do with the effectiveness of the treatment.

Spraying vs. dusting for potatoes. JULIAN G. LEACH.

Comparative spraying and dusting experiments were conducted co-operatively by the Sections of Plant Pathology and Entomology of the University of Minnesota during 1922 and 1923, in which the following sprays and dusts were used.

Liquid Bordeaux Mixture (4–4–50) (1922 and 1923).
Liquid Bordeaux Mixture and Black Leaf 40 (1922 and 1923).
Liquid Bordeaux Mixture and Kayso (1923).
Liquid Bordeaux Mixture and Sodium Silicate (1923).
Dosch Copper Calcium Arsenate Dust (1922 and 1923).
Dosch Copper Calcium Arsenate and Nicotine Dust (1922 and 1923).
Nicotine Dust (1922).
Niagara Nicotine Dust (1923).

The experiments were conducted on 1/10 or 1/12 acre replicated plots at the University Farm and were duplicated on Bliss Triumph and Green Mountain potatoes. All sprays were applied with a Friend power sprayer, using three nozzles per row, and dusting was done with a Niagara power duster. All plots were sprayed or dusted four times.

The average increase in yield per acre over the check plots (sprayed or dusted with arsenates only) was 57 bushels (34 per cent) and 20 bushels (12 per cent) for the sprayed and dusted plots respectively in 1922. In 1923 it was 19 bushels (9 per cent) and 6.5 bushels (3 per cent). This year the leafhoppers were not as numerous as in 1922 and appeared about one month later.

Loss of strength of mercuric chloride solutions used for treating potatoes. R. P. WHITE.

It has been known for some time that mercuric chloride solutions used for treating seed potatoes for scab and Rhizoctonia lose their strength with use. In the experiments recorded here the strength of the original solution was 1–1000. After using this solution four times with whole seed, the strength of the solution was found to be 57.4 per cent of the original strength. When used four times with cut seed, the strength of the solution was found to be 12.5 per cent of the original strength. The area exposed to the solution by the cut seed was approximately twice that exposed by the uncut seed, by actual measurement. The strength of the solution decreased approximately twice as rapidly. In addition to the increase in surface of the potato tuber, there is also a significant increase due to the liberation of starch grains from the cut cells. The surfaces of these grains act as adsorbers of mercury ions and tend to reduce the strength of the solution. Weakening of mercuric chloride solutions used for treating seed potatoes is proportional to the surfaces exposed, that may act as adsorbers of mercury ions.

Potato seed treatment tests in Manitoba. G. R. BISBY.

Four years' tests have shown that black scurf begins to develop on potato tubers at Winnipeg ordinarily during August, and accumulates in increasing amounts through September. There is a variation from year to year in the amount of scurf at a given date, but digging as soon as the potatoes are mature lessens the percentage of black scurf. Neither corrosive sublimate, copper sulphate, copper carbonate, nor semesan exerted any noticeable "residual effect" in preventing the development of sclerotia arising from the fungus in the soil. Semesan may increase the yield somewhat. Both inoculated and non-inoculated sulphur reduced scab, but did not lessen black scurf, and sulphur was not found to be practicable. The potato scab organism may be very abundant in virgin Red River soil. The various seed treatments nevertheless gave better results with scab than with black scurf.

Some factors influencing the development of potato scab. G. B. SANFORD.

Experiments have been made to determine the influence of soil moisture, soil temperature, soil reaction, and the age of the tubers on the development of common scab. Two types of soil were used: a fine textured non-organic sandy loam with a reaction approximately pH 7.2, and a black sandy loam high in humus content with a reaction of approximately pH 6.2. Under controlled moisture and temperature a maximum of scab developed in dry soils at 14° C., 17° C., and 22° C. Soil moisture has appeared to exert a much greater effect on scab development than the temperatures between 14° C.

and 22° C. In all cases the most scab developed in the drier soils, while the most moist soils partially or completely inhibited scab development. Dry soils constantly were slightly more acid than the same soils moist. Tubers appeared most susceptible to infection before they reached one-half inch in diameter. With the Cobbler variety, maximum infection occurred between forty and fifty days after planting. The above facts should be taken into consideration when interpreting results of experiments on scab control.

Further results in the inheritance of immunity to potato wart. FREEMAN WEISS AND C. R. ORTON.

Further tests have been made of first generation hybrid potatoes and a few plants in the F_2 to determine their reaction to wart disease. Owing to the heterozygous constitution of potato varieties segregation is obtained in the F_1. In a few cases families of from 10 to 20 individuals derived from a single cross have been grown, each seedling being multiplied vegetatively so that 25 or more plants have been tested through 1 to 4 years. Grouping the crosses into the following classes gives these results:

	Immune		Susceptible	
Immune × immune or × self	12		0	
Immune × susceptible	35	38	25	28
Susceptible × immune	3		3	
Susceptible × susceptible or × self	1		89	

Immunity is dominant. Reciprocal crosses of immune and susceptible parents react similarly. The small excess of immunes in the combined crosses of this class points to the simultaneous action of 2 factors producing immunity, with a ratio of 9 to 7 as the expectancy. It is possible that only a single factor is involved and that the immune types are heterozygous so that equality of immune and susceptible progeny should be expected, but the individual families usually show an excess of immunes, and none have given ratios agreeing with expectancy if 2 independent factors are concerned as found in England by Salaman and Lesley. The Rural New Yorker and its synonyms behave as homozygous recessives.

Root diseases of sugar cane in Porto Rico. MEL. T. COOK.

The root diseases of sugar cane in Porto Rico have been considered of secondary importance but the numerous reports and field studies of the past few months lead the writer to believe that these diseases are of major importance. These diseases are found in all types of soils. The infected canes are dwarfed and usually show leaf spot symptoms which frequently mislead the field observers. The presence of the cane borer and the white grub also lead to confusion and many growers attribute the entire trouble to these agencies. Careful field studies show the roots to be numerous and decayed and the production of numerous adventitious roots from the nodes, sometimes as much as 20 inches above the ground. Laboratory studies of weak and dead canes demonstrated the presence of *Colletotrichum falcatum*. This organism was also found in some of the slightly infected roots. No definite conclusions as to the primary causes have been reached.

First progress report on the study of apple scab under Ohio conditions. W. G. STOVER AND H. W. JOHNSON.

During the past season, several phases of the apple scab problem were studied on Rome Beauty trees in a commercial orchard near Columbus. The trees were dormant until the middle of April. The buds reached the pink stage about May 4. The first observed discharge of ascospores of *Venturia inaequalis* occurred on April 4 and the last on June 8. The period of heaviest discharge was May 8–21.

The season was favorable for scab development On unsprayed trees 86 per cent of the fruit was scabbed. The disease was first observed on the leaves on May 22, and on the fruit on June 4.

Liquid lime sulfur and Bordeaux mixture gave satisfactory control. Foliage injury occurred where Bordeaux was applied after bloom. Neither sulfur dust nor copper-arsenic dust gave commercial control. Fair control was secured where the trees were sprayed with lime sulfur before bloom and dusted with sulfur after bloom. Lime sulfur followed by copper-arsenic dust failed to give commercial control.

The pink spray was the most important single application in the schedule this year, while the prepink was of practically no value. Weather conditions were not favorable for infection before the pink spray.

Studies on apple blotch in Ohio. W. G. STOVER AND CURTIS MAY.

Examination of Smith Cider twigs with blotch cankers, collected near Columbus, showed that viable spores were present in considerable number from the middle of April until the middle of August. Spores were found in pycnidia in diseased fruits from July 9 to August 29.

Bagging experiments showed that the first infections occurred June 4–8, sixteen days after the petal fall spray. Infection continued until after July 27, when the last of the bagged fruits were exposed. The disease was first observed on the fruit on June 29, three weeks after the earliest infection period as determined by the bagging experiments.

Other studies indicate that many, perhaps most, of the twig cankers originate from lesions on the petioles, as previously reported by others.

Spraying with Bordeaux 3–6–50 (hydrated lime) at petal fall and 2, 4, 6 and 10 weeks later gave an average of 90 per cent blotch-free fruit while 60 per cent of the fruit on unsprayed trees was blotched. At each application one tree was left unsprayed. Under the conditions of this experiment no one application was more effective than the others.

Three little known diseases of strawberries. C. D. SHERBAKOFF.

(1) Lilac softrot of berries and (2) brown hardrot of berries were common and destructive during the past season in Tennessee. Isolations from interior of diseased tissues gave a Pythium from the softrot and a Rhizoctonia from hardrot. The first disease affects half-ripe and ripe berries. In the latter case the color of the rot is lilac. The hardrot affects the berry in all stages of its development; the growth in diseased portions is arrested, thus producing a more or less one sided berry. (3) Blackrot, a disease of very wide occurrence in Alabama and Tennessee and apparently farther north, has assumed proportions of a cosniderable economic importance in certain districts; it is manifested by blackening of the roots from the crown downward. Many

of the affected plants begin to die shortly before the time of maturity of the berries; however, most of the plants survive through the season but with most of the leaves dead; on many occasions the same fungus was isolated in pure cultures from the diseased roots; the fungus so far remains sterile and is characterized by the production of dark "plate" in culture.

Powdery mildew of raspberries. JULIAN G. LEACH AND J. L. SEAL.

A powdery mildew affecting both red and black raspberries was very prevalent in Minnesota in 1923. It does not appear to be very destructive although in cases of heavy infection of young plants or young shoots a distinct dwarfing may result. Affected leaves are usually more or less curled and wrinkled and are mottled with pale green to yellow blotches. Affected plants show considerable resemblance to mosaic or leaf curl, depending upon the degree of infection. The mycelium is confined almost entirely to the under surface of the leaves. On account of the normal white pubescence of the leaves, the mildew is often not recognized.

In view of the quarantines against mosaic, leaf curl, and blue stem of raspberries recently enacted by several states, which will necessitate extensive inspection and rogueing, the above observations should be given publicity. This is particularly true since much of the inspection and rogueing will probably be done by men not especially trained in pathology.

Spray injury. H. C. YOUNG AND R. C. WALTON.

During the past summer there was an unusual amount of injury to foliage and fruit from spray materials. A study was made of the various types of injury to apple, peach and pears. It was found that the injury resulting from the sulphur sprays could be grouped under 5 types, namely, edge burn, leaf scald and goose neck with lime sulphur, and injury following scab, and yellow leaf with almost all types of sulphur sprays. The injury from copper sprays was as serious on the leaves as any of the sulphur sprays and in addition caused russeting on 90 per cent of the Greening apples. Likewise, experiments were conducted with Barium tetrachloride and calcium arsenate. The exact cause of the injury in any case was not determined except that weather conditions had a decided influence on the amount of injury. This paper is intended as a progress report, and the physiological and chemical phases are being continued. The investigation was carried on in New York and Pennsylvania under the auspices of the Crop Protection Institute.

Colloidal sulphur as a spray material. H. C. YOUNG.

This paper is simply a report of progress. Experiments were conducted to test out the fungicidal value of colloidal and precipitated sulphur using the same methods of preparation as that reported in the Annals of the Missouri Botanical Garden, 1922. The tests were made in five states, namely, New York, Pennsylvania, Virginia, Illinois and Michigan. The materials were prepared at the Geneva Station and sent to the cooperating stations.

In all the states both mixtures controlled scab almost completely. There was no injury to foliage except with one application of colloidal sulphur in New York State. With the precipitated sulphur there was no injury whatever, and the foliage looked the best of any sprayed or unsprayed plots.

Both types of sulphur were applied to peaches, grapes, cherries and pears. The colloidal sulphur injured the leaves slightly in some cases, but the precipitated injured in no case. The most succulent foliage of peaches and grapes showed no injury with precipitated sulphur. It was impossible to purify the colloidal sulphur mixture so as to free it of soluble materials with the equipment at hand which, undoubtedly, was the factor in producing injury.

A number of similar compounds are now being produced commercially. This work was headquartered at the N. Y. Agricultural Experiment Station and done under the auspices of the Crop Protection Institute.

Seed transmission of root-knot nematode resistance in the peach. J. A. MCCLINTOCK.

During the seasons of 1922 and 1923 second generation seedlings, from peach trees, which had proven resistant to root-knot, were grown in nematode infested soil. Examination at the close of each growing season showed that a large per cent of these second generation seedlings were free from root-knot. Peach seedlings of the Georgia Belle variety, and also tomato and lettuce plants showed abundant root-knots when grown in the same soil.

These results indicate that nematode resistant peaches transmit this factor of resistance to a high degree through the seed during the first two generations. This offers a solution of the nematode problem in peaches, through the use of resistant seedlings as stocks upon which to bud standard varieties of peaches.

A more detailed account of this work has been submitted for publication.

Present status of stem and bulb nematode in America. G. H. GODFREY.

The stem and bulb infesting nematode, *Tylenchus dipsaci*, is increasing in importance in America. During the past year it has spread abundantly in areas where it has been under observation. Furthermore, it has been found to be much more widespread than was at first supposed. In the susceptible crops that are adapted to rotations, such as clover, bulbs, and strawberries, reasonable control can be secured as a rule without great economic loss. In the case of alfalfa, with which rotations are not so practicable, however, the disease is capable of becoming more serious. These nematodes have been grouped according to host preference into so-called biologic strains. Under favorable conditions for infection, such as those existing in a cool but humid locality, certain strains have shown their ability to reach out beyond these bounds. Potato, onion, pea, buckwheat, turnip and other crops may be infested by nematodes from one or more of the primary hosts. The possibility of gradual adaptation to new hosts is indicated. Nematode infested dandelions (*Taraxacum officinale*) were found in western New York, in Ontario, Canada, and at Boston, Mass. Their wide spread has been explained, in part at least, by the finding of nematodes actually within the seeds. They may thus be carried by the wind and established in a new locality.

Relative susceptibility of red clover to anthracnose and mildew. JOHN MONTEITH, JR.

A number of plantings have been made in various States under the direction of Dr. A. J. Pieters to compare imported red clover seed with home grown seed from various sources. On these plots and in greenhouse tests it has been observed that there is a striking difference in resistance to certain diseases. In sections where anthracnose has been common the plots planted with seed of Italian origin have been practically killed

out. Plants from seed grown in Italy or other countries of southern Europe have appeared to be most susceptible to injury by anthracnose (*Colletotrichum trifolii* and *Gloeosporium caulivorum*). Some strains of home grown red clovers are the most resistant of any lots tried thus far. This greater resistance to the disease does not apply to all American clovers for some lots appear as susceptible as certain of the imported lots of seed. These plots also showed different degrees of susceptibility to powdery mildew in the reverse order to the susceptibility to anthracnose. The Italian clovers which are most susceptible to anthracnose are most resistant to mildew while certain of our American strains which are most resistant to anthracnose are most susceptible to powdery mildew.

An investigation of clover root rot. W. J. YOUNG.

A large number of cultures of Fusaria were isolated from the roots of clover plants killed by root rot. Comparative study reduced cultures to about twelve strains which were used for inoculating clover plants in the greenhouse. Some strains proved harmless, others gave rise to definite cankers on the tap root but none were able to kill the clover plants outright.

Conclusion: Some of these Fusaria are weak parasites which are able to infect clover but require the cooperation of other deleterious agencies to induce fatal results.

The range of toleration of hydrogen-ion concentration exhibited by Fusarium tracheiphilum in culture. A. J. MIX AND DOROTHY LEE VAUGHN.

A strain of *Fusarium tracheiphilum* from cowpea was grown on potato dextrose agar and in potato dextrose broth to which varying amounts of lactic acid or of NaOH were added. Growth occurred on the agar at all concentrations tried between pH 2.6 and pH 11.8. No growth occurred at pH 2.4 or pH 12.2. In the broth growth occurred at all concentrations tried between pH 2.96 and pH 11.42. No growth occurred in broth with initial concentration of pH 2.65 or pH 11.58.

The wide range here shown is perhaps interesting in view of the specialized nature of the parasite.

Studies are in progress to learn the optimum concentration for growth, and the effect of the growth of the fungus on the hydrogen-ion concentration of the medium.

Two bacterial diseases of gladiolus. LUCIA MCCULLOCH.

An undescribed leaf blight, particularly destructive to young stock, has been found on several varieties of gladiolus. The spots are translucent, usually angular, water-soaked, dark green, becoming brown. From these lesions there is a copious bacterial exudate in which soil particles become imbedded.

The organism, which produces a yellow, viscid growth on culture media, has been isolated repeatedly, its characters studied and its pathogenicity proved. The group number is 211.2322523. The name proposed for this organism is *Bacterium gummisudans*. A complete description of this disease has been submitted for publication.

The other disease, caused by *Bacterium marginatum* L. McC., was reported briefly in Science, August 5, 1921, as a rot occurring at the base of gladiolus leaves. Further study demonstrated that this organism is also the cause of a characteristic disease of gladiolus corms. Husk lesions are brown to black, causing holes or cracks. On the body of the corm the spots are circular, depressed areas, yellow to brown, horny in

texture, easily removed, leaving clean saucer-shaped pits. In these lesions of husk and corm the bacteria remain viable and pathogenic from season to season, thus providing a source of infection wherever the diseased corms are planted.

Minnesota sunflower diseases in 1923. A. W. HENRY AND H. C. GILBERT.

Septoria helianthi Ell. & Kell. and *Puccinia helianthi-mollis* (Schw.) Jackson together and separately, caused serious defoliation of *Helianthus annuus* L. in different sections of Minnesota this year, particularly on land which had borne several successive crops of sunflowers. One hundred per cent of the plants in such fields were commonly infected with both fungi. The damage was less severe in several instances where sunflowers were grown in rotation. The Septoria leaf spot was frequently more destructive than the rust. Both diseases first appeared on the cotyledons but the Septoria leaf spot spread more rapidly during the early part of the summer while the rust did not become abundant until later in the summer. Nineteen varieties of cultivated sunflowers were severely infected with these diseases at St. Paul. A downy mildew also occurred on nine varieties of late sown sunflowers at St. Paul and was apparently responsible for severe stunting of from ten to ninety per cent of the plants in different rows.

Fungous diseases of the China aster. W. O. GLOYER.

The following parasitic fungi on the China aster were studied: *Ascochyta asteris* (= *Phyllosticta asteris* Bres.), *Botrytis cinerea*, *Coleosporium solidagnis*, *Fusarium sp.*, *Phytophthora sp.*, *Rhizoctonia solani* and *Septoria callistephi*. The leaf spots caused by Ascochyta, Botrytis, Coleosporium and Septoria were controlled by spraying with Bordeaux mixture. Ascochyta, Botrytis, Fusarium and Septoria are seed-borne and seed treatment with mercuric chloride proved more practical than spraying the plants. Botrytis, Fusarium, Rhizoctonia and Septoria may cause damping off and stem rot. Septoria is viable on two-year-old seed. As Septoria and other fungi winter on the stalks, they should be burned. Asters are susceptible to the other diseases studied during the seedling and seed producing periods, but the plants are attacked by Fusarium and Septoria at any period of their growth.

Where mercuric chloride (1–2000) was applied to the seedlings, Septoria and damping off were controlled. When applied at the time of transplanting no injury was noted where the soil was moist. Where the soil was dry the plants were badly stunted by 1–1280 and less by a 1–2000 solution. Three applications showed no injury if the root systems were well established.

Control chambers for plant environmental studies. JAMES G. DICKSON.

From the experimental studies conducted at Wisconsin on the relation of environment to disease development has evolved a series of chambers in which both temperature and relative humidity have been under control in the same compartment. Credit is gladly given Dr. Chas F. Hottes for the original suggestions in connection with these chambers although the methods of regulation are somewhat different from those developed by him. A gentle current of air is circulated continuously through the chamber by means of a small motor driven blower. The tempering of this air current is accomplished by deflecting part or all of it through a series of heating, cooling, and humidifying compartments by means of two, two-way mixing dampers controlled by a pneumatic, graduated

thermostat and humidostat respectively. As the instruments used in the chambers are regular, stock equipment used in commercial heating and ventilating installations, the cost of construction is reduced to a minimum. The average variation in temperature and relative humidity has been within 3° C., and 5 per cent respectively, even when operating in full sunlight or under artificial illumination. The same temperature control equipment installed in four greenhouses has given good temperature regulation from November 1 to May 15.

(Cooperative investigations by the Wisconsin Agricultural Experiment Station and the Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture.)

Tests of dehydrated culture media. G. H. COONS.

The development of dehydrated culture media for plant pathological work seems desirable. Besides the various media prepared for bacteriological uses, 'cornmeal" agar, prune juice agar, and lima bean agar have been prepared by the Digestive Ferments Co. of Detroit, Mich., following standard formulae. The first named, "cornmeal" agar, is a synthetic agar containing only pure glucose, pure dextrin and "Bacto" agar. The others are dehydrated infusions with agar added. In addition to these media, Coons' synthetic broth and Czapek's synthetic broth have been prepared in dehydrated form. The following table shows the results of tests made with various organisms using these in comparison with home-made media of similar formula.

		Sclerotinia cinerea		*Plenodomus fuscomaculans*		*Colletotrichum lindemuthianum*	
Agar Medium	P_H	Mycelium	Spores	Mycelium	Pycnidia	Mycelium	Acervuli
"Cornmeal," Difco.	5.7	+	+++	++	+++	+++	+
Cornmeal, Home made	5.9	+	+	+	0	+++	0
Prune, Difco.	4.6	+++	+	+++	+++	+++	+
Prune, Home made	4.4	+++	+++	+++	+	+++	+
Lima Bean, Difco.				++	++	+++	++++
Lima Bean, Home made				+++	++++	+++	+++++
Coons' Synthetic, Difco.	5.5	+++	++	++++	++	++++	++
Coons' Synthetic, Home made	5.15	+	+++++	+++	++++	+++	++++
Czapek's Synthetic, Difco.	5.4	*Sterigmatocystis violacea* made heavy growth, with abundant spores.					
Czapek's Synthetic, Home made	5.2	*Sterigmatocystis violacea* made heavy growth, with abundant spores.					

Ephelis mexicana Fr., Balansia hypoxylon (Pk.) Atk. on sandbur, (Cenchrus echinatus L.). GEORGE F. WEBER.

During the summer of 1922 *Cenchrus echinatus* L. (Sandbur) was found in the vicinity of Gainesville, Florida, often severely attacked by *Ephelis mexicana* Fr. The fungus attacked the inflorescence of the host plant when it was still within the sheath. The inflorescence then was not able to emerge from the boot. The tillers were decidedly stunted but not killed. The green color of the sheath was somewhat darker than normal when the fungus was present. As the fungus developed the whole inflorescence was involved. A soft spongy white mass of mycelia completely covered the floral parts. This gradually darkened to a glossy, jet black and became hard, forming a sclerotium from 75 to 150 mm. long, 2 to 4 mm. wide, often somewhat flattened and tapered more toward the bottom than the top. These sclerotia were collected and placed in a moist chamber. After two weeks small Peziza-like cups con aining conidia developed from the sides of the sclerotia. The conidia germinated readily and grew on potato agar poured plates. After about four weeks, more growths appeared on the sclerotia. A stroma developed which was rough, black, globose, 2 to 5 mm. in diameter. It was pushed up by a stipe often 3 cm. in length. The stroma was filled with perithecia which contained asci and ascospores very similar to *Balansia hypoxylon* (Pk.) Atk. Later, during the winter the two stages were found out of doors buried in sand where diseased plants of *Cenchrus echinatus* L. had previously grown.

Infection-court in radish black-root. JAMES B. KENDRICK.

The natural wound at the point where the secondary root emerges from the cortex of the primary root of the radish appears to be an avenue of infection for the black-root fungus (*Rheosporangium aphanidermatus* Edson). Examination under the binocular microscope of 258 incipient lesions on 45 young White Icicle radishes showed that 98 per cent were located in the cortex of the primary root immediately surrounding the base of a secondary root. The fungus is intercellular Evidences of systemic infection have been found. In young radishes grown in sterilized, inoculated soil, the fungus caused a blackening of the cortex of the stem, petiole, and leaf midrib and a lateral curling of the leaves. In field tests, the variety White Chinese has tended to escape infection.

Sugar beet seed disinfection with formaldehyde vapor and steam. CAROLINE RUMBOLD.

Exposing sugar beet seed balls for 20 minutes to a mixture of formaldehyde vapor and steam with a temperature of 140° F. has been found sufficient in laboratory tests to kill fungus spores and bacteria ordinarily associated with the seed balls.

This treatment impregnates the outermost tissues of the seed balls with formaldehyde without starting the germination of the seed or injuring the viability of the seed. Even after four years' storage, traces of formaldehyde have been found on the seed balls, but a field test in Virginia showed no decrease in germination of the seed. Field tests in Colorado with treated seed are reported to have increased production of sugar per acre. In the author's opinion the increased production was due to destruction of fungus spores or bacteria on the seed balls, although these points have not been experimentally determined.